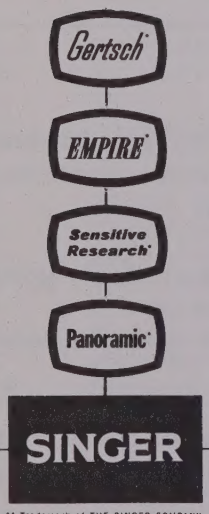
INSTRUCTION MANUAL

Gertsch*

PHASE ANGLE VOLTMETER

PAV-2A/3A/1A



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7. Has maintenance action been previously requested?
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(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

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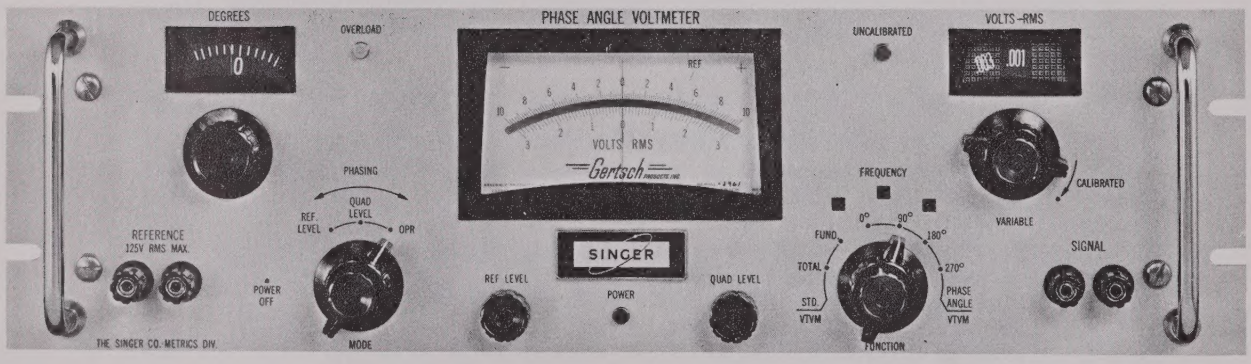


Figure 1-1. Model PAV Phase Angle Voltmeter

SECTION I
GENERAL DESCRIPTION

1-1. MODELS COVERED.

1-2. The instruction book provides operation and maintenance information for Gertsch Models PAV-1A, PAV-2A, and PAV-3A Phase Angle Voltmeters. The models are identical except that Models PAV-2A and PAV-3A include built-in signal and reference isolation transformers. The Model PAV-1A is covered in Sections I through VI and the specific differences of the Models PAV-2A and PAV-3A are covered in Sections VII and VIII.

1-3. GENERAL DESCRIPTION.

1-4. The Phase Angle Voltmeter combines the capabilities of a standard VTVM and a phase sensitive voltmeter into a single unit. In combination with Gertsch synchro and resolver test equipment, the Model PAV provides complete checkout capabilities for AC rotating components. For additional information concerning the use of the Model PAV in checking out rotating components, refer to Gertsch Catalog No. 11.

1-5. As a VTVM, the Model PAV may be used in either of two ways:

a. To measure the total rms voltage of any ac signal in the 50 cps to 20 kc range.

b. To measure the fundamental rms component of a signal. In this application, the instrument will operate at any one of up to three fixed frequencies in the 50 cps to 10 kc range. A band pass filter is switched into the circuit to eliminate noise and harmonics.

1-6. As a phase angle voltmeter, the instrument may be used for a variety of tests in three basic ways:

a. To measure the phase angle between a signal and reference voltage and to measure the amplitude of signal voltage.

b. To measure the in-phase and quadrature components of the signal voltage.

c. As a phase-sensitive null indicator.

1-7. When used as a phase angle voltmeter, the instrument will operate at any one of up to three fixed frequencies in the 50 cps to 10 kc range. The nominal operating frequencies are pre-selected through the use of plug-in components.

1-8. The Model PAV is a self-contained test instrument which only requires connection to a 115 vac power source for operation. By operating a switch and replacing a fuse the unit may be converted for use with a 230 vac power source.

1-9. All operating controls, indicators, and basic connections are mounted on the front panel with a parallel set of connections mounted on the rear of the unit. In addition, a set of binding posts are mounted on the rear of the unit which provide a dc recorder output.

1-10. To provide a "go" "no-go" indication or control of a test system from the Model PAV-1A/MR-1, a relay socket meter relay and connector J9 (on the rear of the unit) is included in the equipment. With this addition of the meter relay, a relay closure is provided at full scale meter deflection.

TABLE I. SPECIFICATIONS

Voltage Range	1 mv to 300 volt, full scale in 12 ranges
Frequency Range	
VTVM (Total voltage)	50 cps to 20 kc
VTVM (fundamental component of total voltage) Phase Angle Voltmeter	Maximum of 3 fixed frequencies in the 50 cps to 10 kc range. These frequencies may be varied ± 5% from the center frequency
Voltage Accuracy	
VTVM (Total voltage)	± 2% of full scale, 50 cps -20 kc
VTVM (fundamental component of total voltage)	± 2% of full scale at center frequency ± 3% of full scale over frequency range of ± 5% from the center frequency
Phase Angle Voltmeter	± 3% of full scale at center frequency
Phase Angle Dial Accuracy	Better than ± 1°
Signal Input Impedance	Approximately 10 megohms
Reference Input Impedance	Approximately 1 megohm
Reference Input Voltage	1 to 125 vrms
Nulling Sensitivity	5 microvolts
Overload	Overload lamp lights when total input signal exceeds 10 times the selected voltage range
Harmonic Rejection (phase sensitive voltmeter)	55 db minimum
Recorder Output	± 25 mv dc at full scale (approx)
Power	115/230 vac, 50 to 60 cps, 60 va
Size	
Model PAV (rack mounting)	5-1/4"H by 19"W by 12"D
Model PAV (case)	7"H by 20"W by 15"D

TABLE 2. FUNCTION OF OPERATING CONTROLS, INDICATORS, AND CONNECTORS

PANEL MARKING	TYPE OF CONTROL	FUNCTION
MODE	3 position rotary switch	In the REF LEVEL position, switches circuitry so that the in-phase portion of the reference voltage can be metered and set to the proper operating level In the QUAD LEVEL position, switches circuitry so that the quadrature portion of the reference voltage can be metered and set to equal the in-phase portion. In the OPR position, switches proper connections in for all functions.
PHASING	Variable Resistor	Adjusts phase of the reference circuitry for proper operation at any frequency within ± 5% of the selected frequency. Also includes power switch
REFERENCE LEVEL	Rotary Switch	Adjusts the in-phase portion of the reference voltage to the proper amplitude level
QUADRATURE LEVEL	Variable Resistor	Adjusts the quadrature portion of the reference voltage to the proper amplitude level
FUNCTION	6 position rotary switch S3	In the TOTAL position, switches circuitry to measure measure total rms value of the input signal In the FUND position, switches circuitry to measure the fundamental rms component of the signal In the remaining positions (0°, 90°, 180°, 270°), switches phase of reference voltage in order to measure phase angles or in-phase and quadrature voltages.
FREQUENCY	3 position rotary switch S2	Switches applicable plug-in components into circuit for frequency selected
DEGREES	Variable Resistor	Adjusts the phase angle of the reference voltage required to equal any phase angle within set quadrant. The degrees reading plus the angle selected by the FUNCTION selector indicates the total phase angle.
OVERLOAD	Indicator Lamp	Lights to indicate that the total input signal voltage exceeds the selected range by a factor of 10
UNCALIBRATED	Indicator Lamp	Lights to indicate that the VARIABLE range control has been rotated from the CALIBRATED position. Under these conditions, the meter does not indicate full scale voltages equal to the VOLTS-RMS range selector settings
VOLTS-RMS	12 position rotary switch	Selects full scale voltage range of instrument
VARIABLE	Variable Resistor R46 and switch	Adjusts meter sensitivity for full scale deflection at other than the voltages indicated by the VOLTS-RMS range selector position
	Meter	Zero center meter which indicates rms voltage or nulls.

TABLE 2. FUNCTION OF OPERATING CONTROLS, INDICATORS, AND CONNECTORS (Continued)

PANEL MARKING	TYPE OF CONTROL	FUNCTION
SIGNAL	Binding Posts	Provides front panel connection for input signal
REFERENCE	Binding Posts	Provides front panel connection for reference input
POWER	Indicator Lamp	Lights to indicate application of power
NOTE: The following connectors and components are located on the rear of the unit.		
SIGNAL	Binding Posts	Provides rear panel connection for input signal
REFERENCE	Binding Posts	Provides rear panel connection for a reference input
F1	Fuse	Input power circuit fuse
METER	Pin Jacks	Provides connection for an external dc recording device
CASE GND	Binding Post	Provides rear panel connection for grounding the instrument case
SPARE	Fuse	Spare power fuse

SECTION II
OPERATING INSTRUCTIONS

2-1. PHASE ANGLE VOLTMETER OPERATION.

2-2. PRE-OPERATION ADJUSTMENTS. Before operating instrument as a phase angle voltmeter, adjust as follows:

NOTE

Readjust the instrument whenever the reference input voltage or frequency is changed.

a. Check mechanical zero of meter. Reset if required.

b. Turn PHASING control clockwise from the POWER OFF position and allow instrument to warm up for approximately five minutes.

c. Make certain that the VARIABLE range control is in the CALIBRATED position.

d. Connect reference input voltage to both the REFERENCE and SIGNAL binding posts.

e. Turn MODE switch to the REF LEVEL position.

f. Adjust REFERENCE LEVEL switch until the meter deflects to between one-half and full scale. If more than one switch position provides the required deflection, use the position which provides the deflection closest to half scale. Note meter reading carefully.

g. Turn MODE switch to the QUAD LEVEL position.

h. Adjust QUADRATURE LEVEL control until meter deflects to the reading noted in step f.

NOTE

For accurate reading of the DEGREES dial, the meter indications of steps f and h must be equal.

i. Turn MODE switch to OPR position.

j. Turn FUNCTION switch to FUND position.

k. Starting from the lowest range, turn VOLTS-RMS range selector to the first position which causes an off-scale indication.

l. Turn FUNCTION switch to the 90° position.

m. Set DEGREES dial to 0°.

n. Adjust PHASING control until meter indicates a null.

2-3. PHASE ANGLE MEASUREMENTS. To measure a phase angle and/or fundamental rms vector voltage using the DEGREES control, proceed as follows:

a. Adjust the instrument to the reference input signal as described in paragraph 2-2.

b. Disconnect reference input voltage from SIGNAL binding posts and connect signal.

c. Adjust FUNCTION switch and DEGREES control to obtain a maximum indication to the right on the meter. First set FUNCTION switch to the 0° position and then adjust DEGREES control through its entire range. If the meter does not indicate a positive (to the right) peak deflection, turn FUNCTION switch to the 90° position and repeat adjustment of DEGREES control. Adjust VOLTS-RMS (range) switch as required.

d. Turn FUNCTION switch 90° in either direction from the position at which maximum positive meter deflection was obtained.

e. Adjust DEGREES control to obtain an exact null on the meter. For more sensitive null indications, the VOLTS-RMS (range) switch may be turned to lower ranges until the OVERLOAD lamp lights. When the light does light, use the next higher range. When an exact null is obtained, return the VOLTS-RMS range selector to the original position.

f. With FUNCTION switch in the position (0°, 90°, 180°, 270°) which gives a meter deflection to the right (+), the phase angle between the signal and input reference voltages is equal to the angular position of the FUNCTION selector plus the DEGREES dial indication. The total amplitude of the vector is indicated by the meter (if the VARIABLE range control is in the CALIBRATED position).

2-4. IN-PHASE AND QUADRATURE COMPONENT MEASUREMENTS. To measure the fundamental rms in-phase and quadrature components of a signal voltage, proceed as follows:

a. Adjust the instrument to the input reference signal as described in paragraph 2-2.

b. Disconnect the reference input signal voltage from the SIGNAL binding posts and connect the signal.

c. To measure the in-phase component, turn the FUNCTION switch and DEGREES control to the 0° position. The meter will then indicate the amplitude of the in-phase component.

d. To measure the quadrature component, turn FUNCTION switch to the 90° position and DEGREES control to the 0° position. The meter will then indicate the amplitude of the quadrature component.

NOTE

For more accurate measurements, the VOLTS-RMS (range) switch may be turned to lower ranges until the OVERLOAD light lights. If the light does light, use the next higher range.

2-5. VARIABLE CONTROL USE. If a full scale meter reading, other than those available through use of the VOLTS-RMS (range) switch, is desired, adjust the VARIABLE control as follows:

a. Apply a signal with the required full scale amplitude to SIGNAL binding posts.

b. Turn FUNCTION switch to the desired position.

c. Starting with the highest range, turn VOLTS-RMS (range) switch to the first position which causes an off scale meter indication.

d. Adjust VARIABLE range control until the meter indicates full scale deflection. The UNCALIBRATED light will light when the VARIABLE range control is turned from the CALIBRATED position.

2-6. NULL INDICATOR USE. To use the instrument as a phase sensitive null indicator, proceed as follows:

a. Determine the phase angle of the axis along which a null is desired. This angle will be determined by the application.

b. Set the sum of the FUNCTION selector and the DEGREES dial to equal the angle in step a above.

c. Adjust the unit under test (or external test equipment) until the meter indicates zero voltage (null).

d. To measure the quadrature voltage at null, turn FUNCTION switch 90° from its initial setting in either direction.

NOTE

If an "error" signal is in-phase with the reference angle selected the deflection will be + and - if it is out-of-phase.

2-7. RECORDER INSTALLATION.

2-8. The basic connections for interconnecting the dc recorder are shown in figure 2-1. In connecting a recorder, note the following:

a. The recorder signal input may be adjusted through the use of the VARIABLE range control and the VOLTS-RMS switch of the Model PAV.

2-9. TOTAL VTVM OPERATION.

2-10. To measure the total rms voltage of an incoming signal, proceed as follows:

a. Check mechanical zero of meter. Reset if required.

b. Turn PHASING control clockwise from the POWER OFF position, and allow the instrument to warm up for approximately five minutes.

c. Make certain that VARIABLE range control is in the CALIBRATED position.

d. Connect input signal to SIGNAL binding posts.

e. Turn FUNCTION switch to TOTAL position.

f. Turn VOLTS-RMS (range) switch to the lowest range which provides an on scale reading.

2-11. FUNDAMENTAL VTVM OPERATION.

2-12. To measure the fundamental rms component of an incoming signal (less noise and harmonics), proceed as follows:

a. Check mechanical zero of meter. Reset if required.

b. Turn PHASING control clockwise from the POWER OFF position and allow instrument to warm up for approximately five minutes.

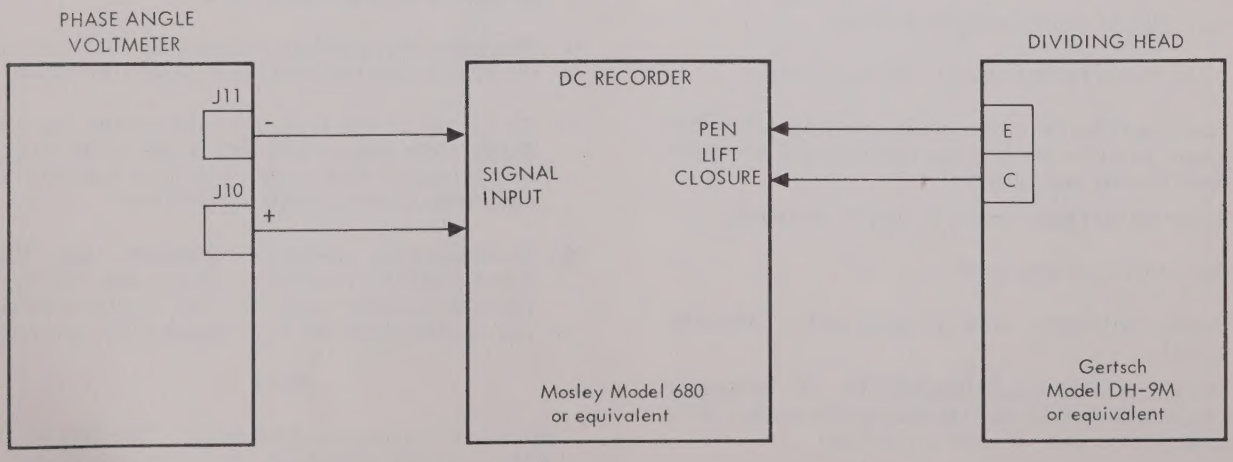


Figure 2-1. Recorder Installation

c. Make certain that the VARIABLE range control is in the CALIBRATED position.

d. Connect input signal to SIGNAL binding posts.

e. Turn FUNCTION switch to FUND position.

f. Turn FREQUENCY switch to the selected frequency.

g. Turn VOLTS-RMS (range) switch to the lowest range which provides an on scale reading.

2-13. NOTES ON OPERATION.

2-14. GROUND LOOPS. Ground loops should be avoided particularly when the unit is used as a phase sensitive voltmeter. To avoid ground loops (with PAV-1A), use isolation transformers (Gertsch Model ST103 and ST102 respectively, or equivalent) in the signal and reference input circuits.

2-15. VENTILATION. The model PAV requires good ventilation for proper operation. When the unit is mounted with other equipment, make certain that air at ambient temperature is available for ventilating the unit. The dust covers, which are furnished with the case model, are only required if the unit is removed from the case. If the unit will be operated in the case, the dust covers should be removed to allow adequate ventilation.

2-16. NOISE PICKUP. Noise pickup will be maximum on the 1 volt and 1 mv scales. Noise pickup should be tested on the above scales with the input shorted and should not exceed 1/4 of a division (5 uv on the 1 mv scale, or 5 mv on the 1 volt scale). If excessive noise is encountered with the FUNCTION switch in the FUND position, the trouble may be due to an external magnetic field inducing a voltage into the internal filters. If the unit is a PAV-2A or PAV-3A and the excessive noise is encountered with the signal input isolated, the trouble may be due to an external magnetic field inducing a voltage into the signal isolating transformers.

2-17. BEAT NOTES. If the power and reference voltage have the same frequency, the two sources must be phase locked. Any difference in frequency can result in beat notes which in turn cause erroneous voltage indications.

SECTION III
THEORY OF OPERATION

3-1. GENERAL THEORY.

3-2. The signal circuitry, shown in the top section of the block diagram (figure 3-2) provides the range control circuitry and amplification for the signal input. The reference circuitry, shown in the bottom section of the block diagram, converts the reference input signal to the proper reference signal for the phase-sensitive detector.

3-3. STANDARD VOLTMETER. When the instrument is used as a standard voltmeter, the reference circuitry is switched out and a full-wave rectifier is used as the meter detector. In the total function, the signal circuit is broad band and therefore the total incoming signal is applied to the meter circuit. The meter circuit is an average measuring circuit but the meter is calibrated to indicate rms value. In the fundamental function, one (of possibly three) band pass filter is switched into the signal circuit to minimize noise and harmonics. Under these conditions, the meter indicates the fundamental rms value of the incoming signal.

3-4. PHASE ANGLE VOLTMETER. When the instrument is used as a phase angle voltmeter, a phase-sensitive bridge circuit is used as the meter detector. The reference circuit is switched into the system and supplies a reference signal with an adjustable phase angle to the bridge. The input and reference signals are compared in the phase-sensitive bridge. When the phase angle of the detector reference signal is adjusted to exactly equal the phase angle of the input signal, the detector output is maximum. Since a filter is switched into the signal channel, the meter indicates the fundamental rms value of the signal input.

3-5. If there is a phase shift through a unit under test, the output signal as related to the input signal contains two components: an in-phase component (X) and a quadrature component (jY). As shown in Figure 3-1, the phase angle is determined by the relative amplitudes of the components and by the arithmetical signs (plus or minus). At 45°, the amplitudes are equal and both components have a plus sign. At 225°, again the amplitudes are equal, but both components have a minus sign.

3-6. The reference circuitry uses the reference input signal to generate the detector reference signal. The in-phase portion (X) is obtained by using the reference signal without change. The quadrature portion is obtained by shifting the phase of the reference voltage 90° in a quadrature generator. The two components are combined in the quadrant selector and the calibrated phase shifter.

3-7. CALIBRATED PHASE SHIFTER. The calibrated phase shifter is essentially a potentiometer with an in-phase component applied to one end and a quadrature component applied to the other. At the midpoint of the potentiometer, the two components are equal. If both components have a plus sign, the midpoint equals a phase angle of 45°. The dial for the potentiometer is calibrated in 1° increments.

3-8. QUADRANT SELECTOR. The quadrant selector determines the quadrant of the phase angle by determining the signs of the components. Either (or both) component is changed to a minus sign by inverting the voltage 180°. Through the coarse angular selection of the quadrant selector and the fine selection of the phase shifter, the phase angle of the detector reference signal may be continuously adjusted from 0° to 360°.

3-9. ADJUSTMENT CIRCUITS. For proper operation of the reference circuitry, (1) the reference voltage must be set to a predetermined level, (2) the two components applied to the calibrated phase shifter must be exactly equal, and (3) any inherent phase shift within the instrument must be balanced for both the reference and signal circuits.

3-10. The input reference voltage may vary from 1 to 125 vrms. To set this voltage to a predetermined level, a reference level and mode switch are included. In the reference level mode, a small portion of the in-phase component is applied to the standard voltmeter circuit. Proper setting of the switch provides a half to full scale meter deflection.

3-11. To ensure that the two components applied to the calibrated phase shifter are equal, the quadrature level control and switch mode are included. In the quadrature level mode, a small portion of the quadrature component

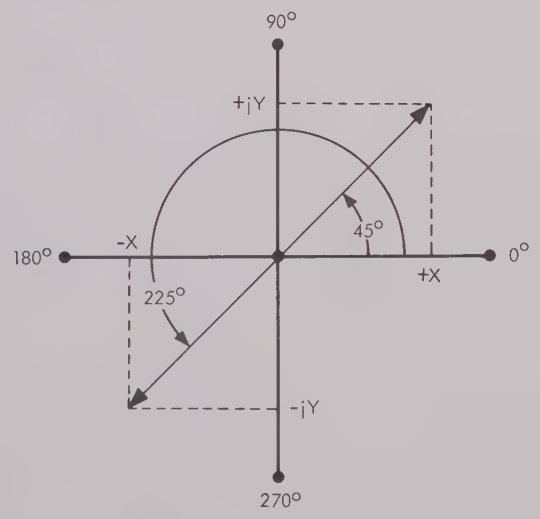


Figure 3-1. Input to Output Signal Relationships

is applied to the standard voltmeter circuit. The quadrature component must be set to exactly the same level as the in-phase component.

3-12. If the inherent phase shift through the reference and signal channels is unbalanced, the unbalance represents unwanted phase shift in the reference channel. The phasing control allows adjustment of the reference channel to compensate for the unwanted phase shift.

3-13. SIGNAL CIRCUITRY. (See figure 3-3.)

3-14. RANGE CONTROL. Range control is provided by a two step input attenuator and a six step second attenuator. In the six lower ranges (1 mv to 300 mv), the input signal is applied directly to the grid of the cathode follower VI. In the six higher ranges, the signal is applied through the 1000:1 attenuator consisting of resistors R1, R2, and R3.

3-15. Resistor R3 adjusts the attenuator for an exact 1000:1 ratio at the low frequencies. Capacitors C2 and C3 adjust the 1000:1 ratio at the higher frequencies. Capacitor C2 affects not only the 1000:1 ratio at the higher frequencies but also the phase shift at the low frequencies. The six step second attenuator consists of a straight through resistor R10 for the lowest range and five symmetrical T-pads. The T-pads provide the precise attenuation required for the various ranges.

3-16. BAND PASS FILTERS. With function switch S3 in the TOTAL position, the output signal from the second attenuator is applied directly to amplifier V2. In any other position, the signal is applied through one of the filters FL1, FL2, or FL3. The filters, provide a pass band of ± 5 percent from center frequency and 45 db attenuation at 1/3 and 3 times the center frequency. Resistors R26, R28, and R30 equate the insertion losses for the three filters. In any one of the phase-sensitive modes, this attenuation is increased to 55 db at 1/2 and 2 times the center frequency.

3-17. AMPLIFICATION. Amplification of the signal is provided by amplifiers V2 and V3. Amplifier V2 drives the pentode section of V3 which in turn, drives its own triode section. The triode section is connected as a cathode follower and provides isolation between the amplifiers and the meter circuit. Capacitor C11 provides positive feedback to increase the open loop.

3-18. Calibration of the meter circuit is accomplished by controlling the feedback. The output of cathode follower V3 is fed back to amplifier V2 through the meter circuit. Three potentiometers, R38, R36, and R47 affect the amount of feedback. In the TOTAL position all three potentiometers are in the circuit and affect the amount of feedback. In the fundamental position, potentiometer R38 is switched out of the feedback circuit.

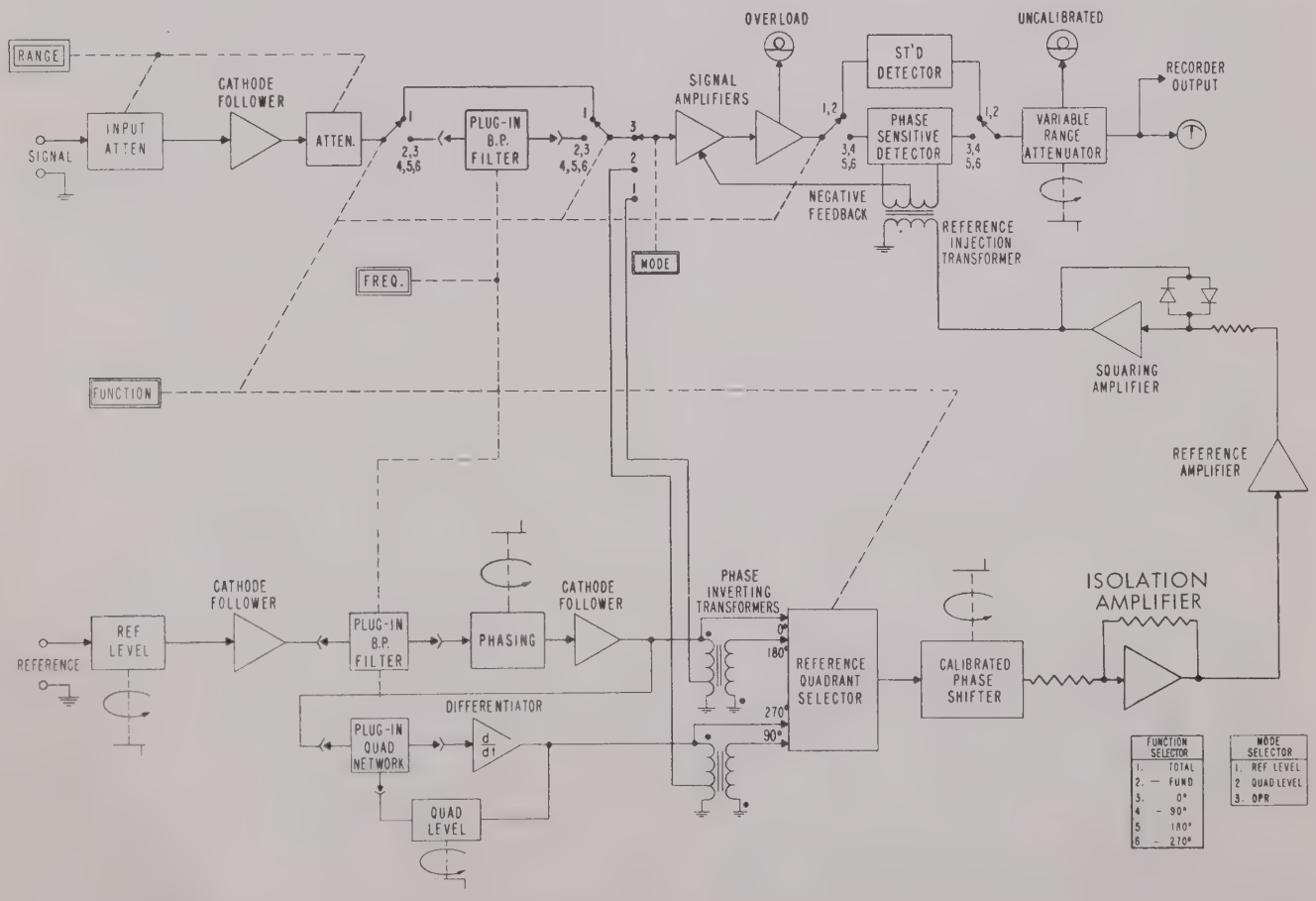


Figure 3-2. Block Diagram

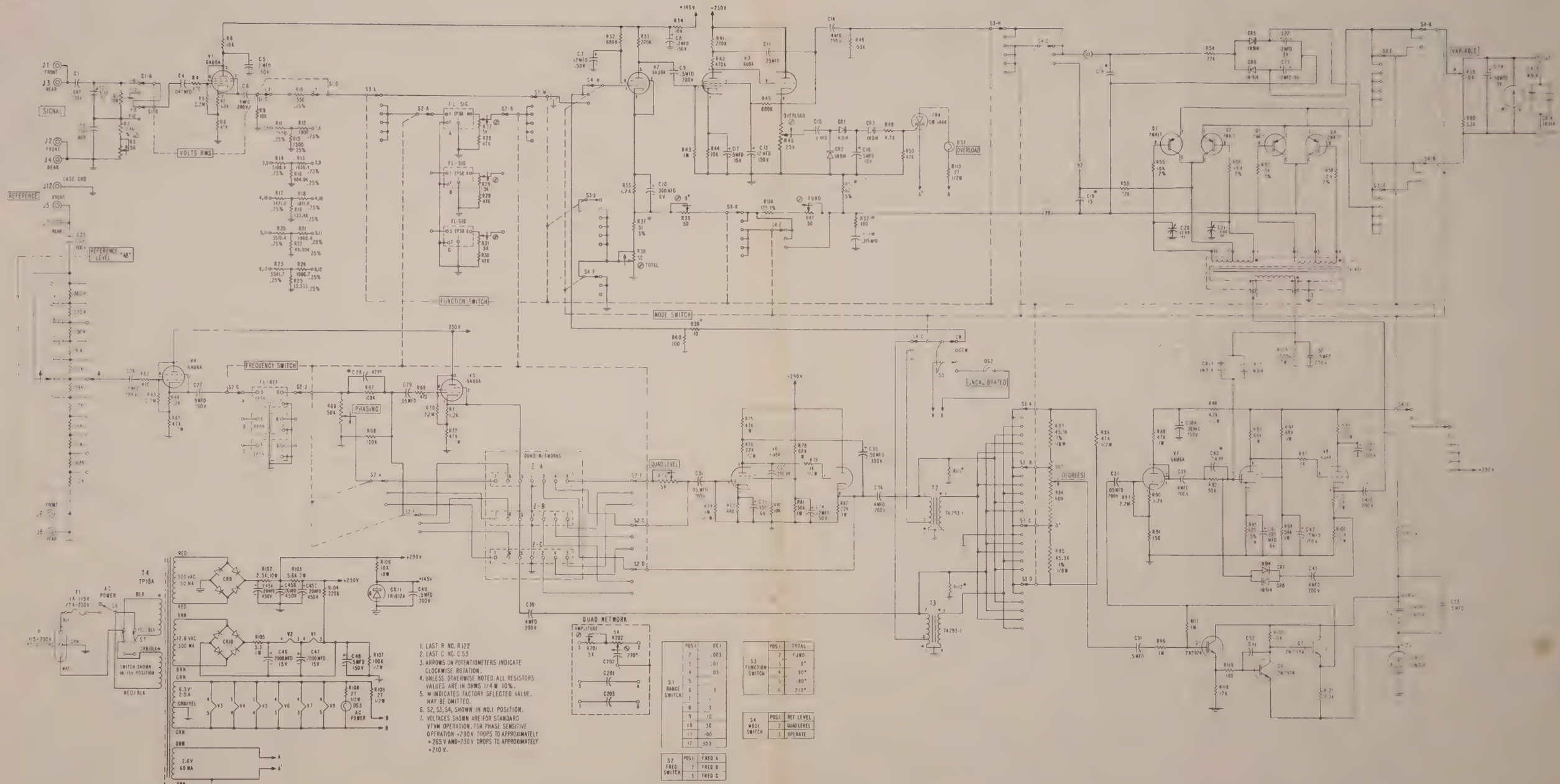


Figure 3-3. Schematic, Model PAV-1A

The resultant decrease in feedback compensates for the loss of gain through the filters. In any of the phase angle positions potentiometer R47 is also switched out of the feedback circuit. The resultant increase in feedback compensates for the difference in the detectors.

3-19. OVERLOAD INDICATOR. When the instrument is operating as a phase angle voltmeter, the amplified signal can exceed the indicated signal on the meter by a large amount. Under these conditions, the amplifiers may be driven to a non-linear portion of their operating curves regardless of the meter indication. To eliminate this source of error, overload indicator DS1 is lit whenever the signal in the amplifier exceeds full scale meter voltage by a factor of ten.

3-20. A small portion of the amplifier signal is selected by potentiometer R46 and applied to the overload circuit. This portion is rectified by diodes CR1 and CR2 and filtered by capacitor C15, diode CR3, and resistors R49 and R50. The resultant dc voltage functions as the gate voltage for SCR diode CR4. When the gate voltage is approximately 1/4 vdc, the diode fires and completes the circuit for the overload lamp.

3-21. STANDARD DETECTOR.

3-22. Meter M1 is connected into a full-wave rectifier circuit as shown in figure 3-4; whenever mode switch S4 is in the reference level or quadrature level positions, or when function switch S3 is in either VTVM position. The diagram also shows the feedback circuit for the total function.

3-23. During one half cycle, diode CR5 conducts and applies a negative voltage to the negative side of the meter. During the alternate half cycle, diode CR6 conducts and applies a positive voltage to the other side of the meter. Capacitor C24 and resistors R59 and R60 provide meter filtering with a long time constant.

3-24. Variable range control R59 and switch S5 allow the meter circuit to be adjusted for a full scale indication. Potentiometer R59 controls the current flow through the meter. With the control fully clockwise, the meter indicates actual input voltage and uncalibrated light DS2 is turned off. With the control fully counterclockwise, the actual input voltage is approximately three times the indicated voltage. Whenever the control is turned from the calibrated position , switch S5 supplies power to light DS2. To eliminate problems of incorrect reference level settings, the reference and quadrature level voltages are disconnected from the meter circuit during uncalibrated operation, thereby disabling the reference level and quadrature level mode.

3-25. PHASE SENSITIVE DETECTOR.

3-26. When the function switch is turned to one of the phase angle voltmeter positions, the meter is connected into a phase sensitive bridge circuit as shown in figure 3-5. In this type of circuit, the reference voltage operates as a switching source.

3-27. During one half cycle of the reference voltage, terminal 16 of transformer T1 is negative with respect to terminal 15. Terminal 6 is also negative with respect

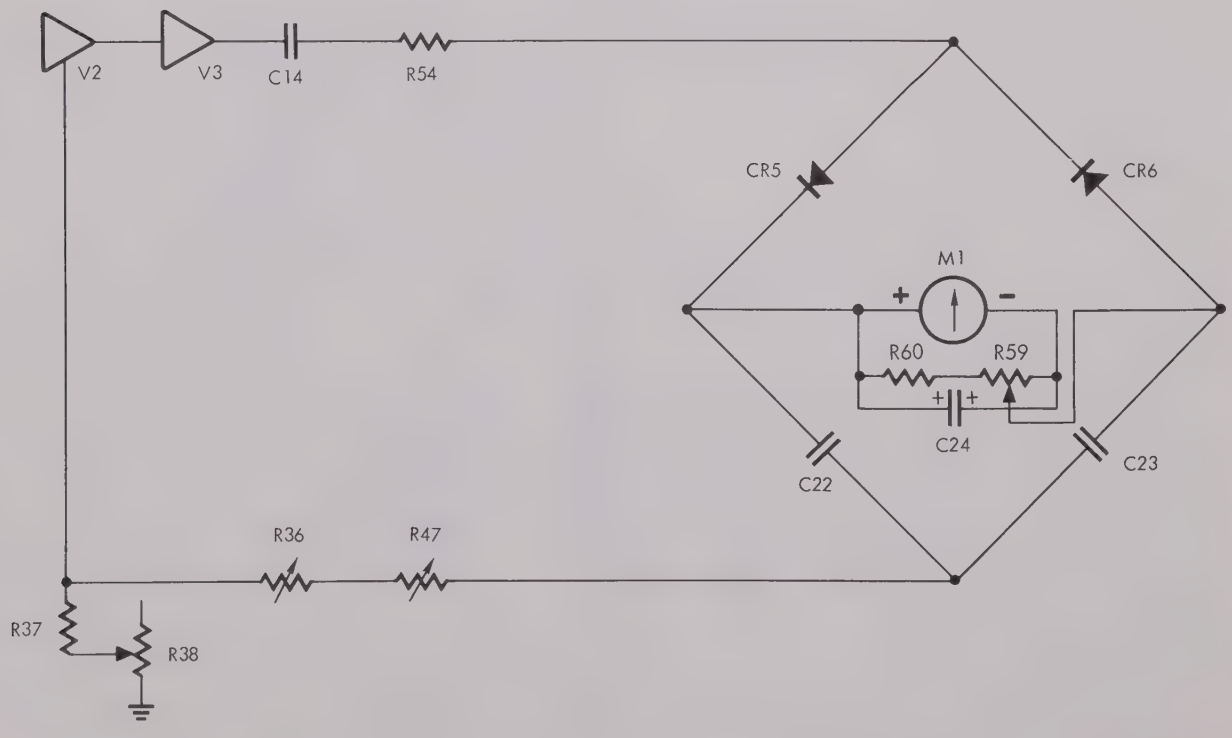


Figure 3-4. Simplified Diagram, Full Wave Rectifier

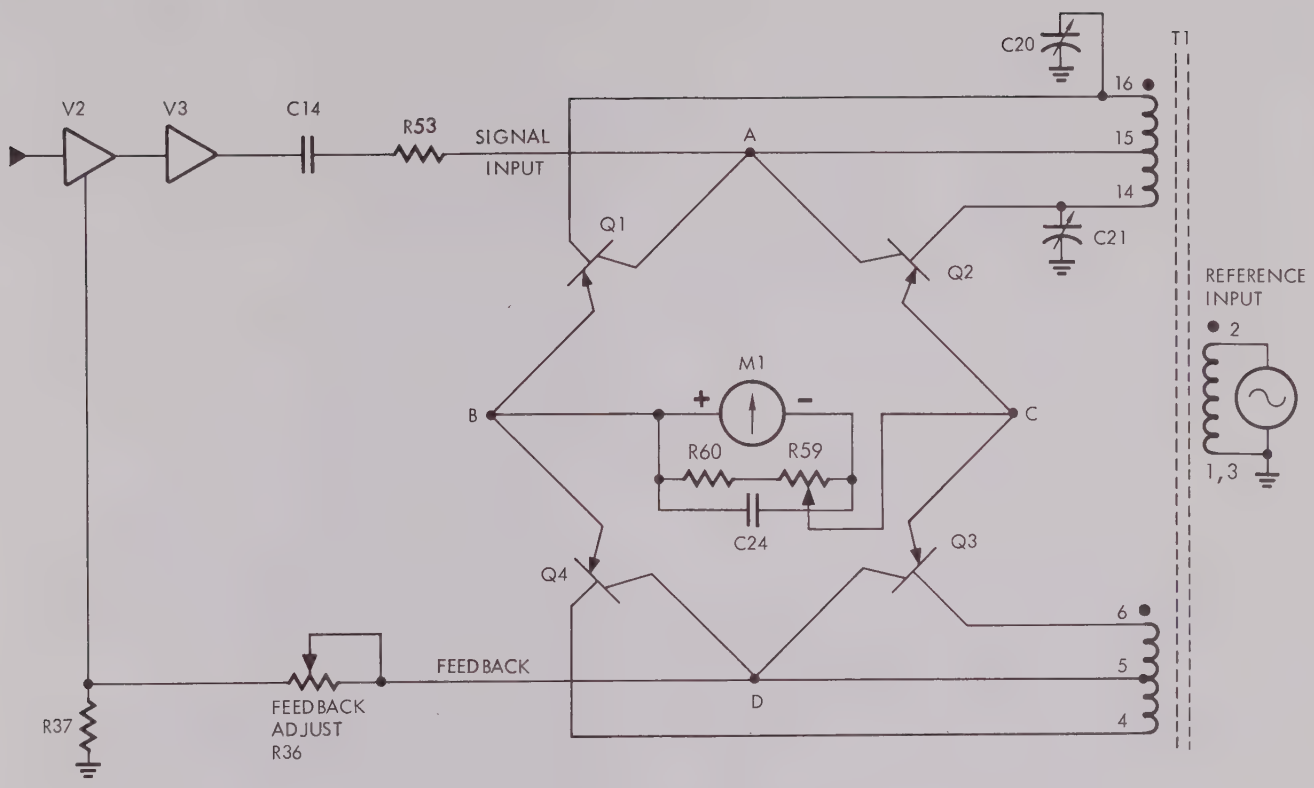


Figure 3-5. Simplified Diagram, Phase Sensitive Bridge Circuit

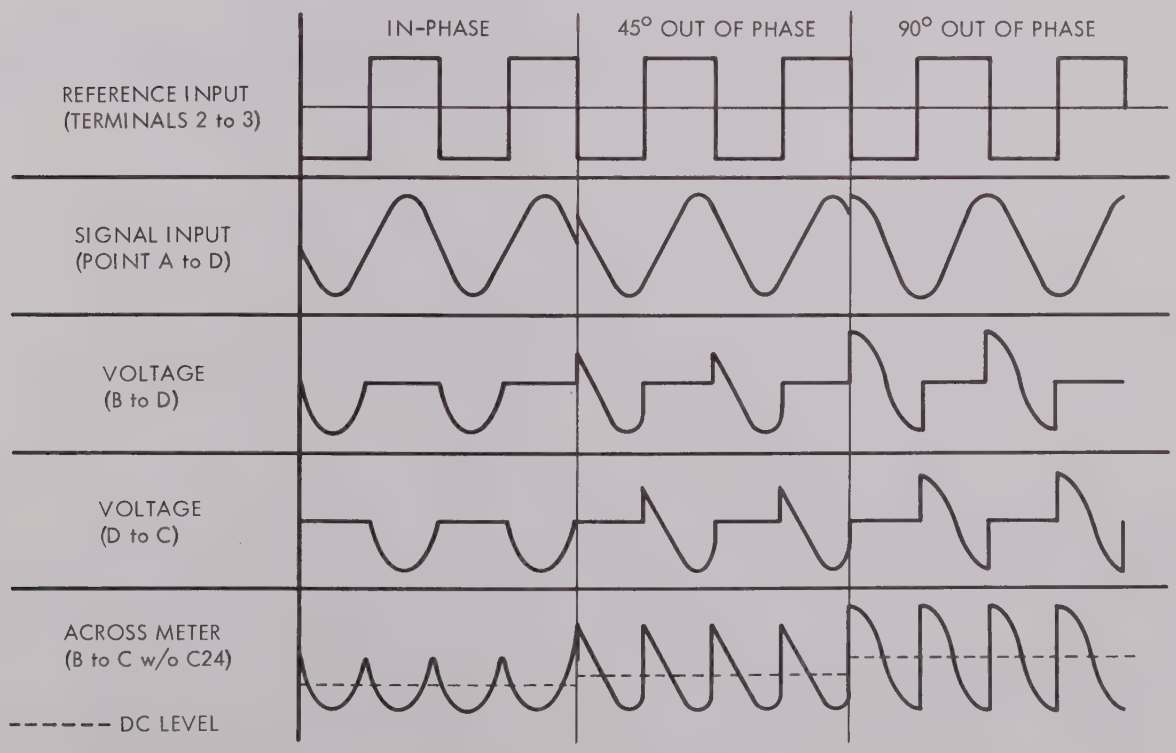


Figure 3-6. Phase Sensitive Detector Wave Forms

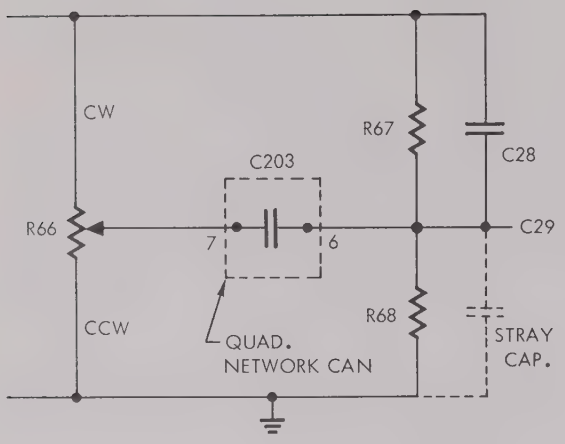


Figure 3-7. Phasing Circuit

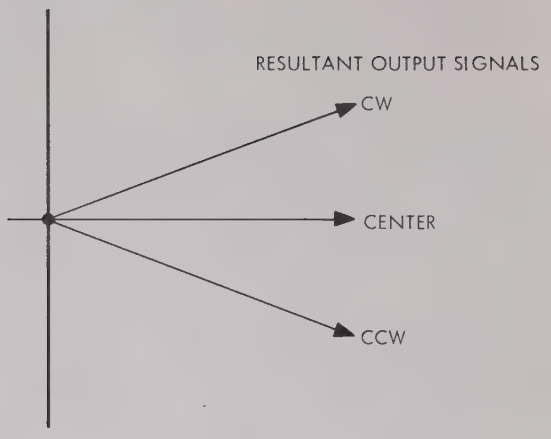


Figure 3-8. Phasing Circuit Output Signals

to terminal 5. The bases of transistors Q1 and Q3 are therefore negative with respect to the collectors (inverted mode switching) and the transistors conduct. Since the bases of transistors Q2 and Q4 are positive, the transistors are cut off. During the alternate half cycle, transistors Q2 and Q4 conduct and transistors Q1 and Q3 are cut off. To ensure rapid switching, the reference input to the bridge circuit is a square wave.

3-28. During one half cycle, the conduction path is from point A to B to C to D. During the alternate half cycle, the conduction path is from point D to B to C to A. As shown in figure 3-6, the average voltage applied across the meter (B to C) is determined by the phase relations of the reference and signal voltages. Maximum voltage develops when the two signals are in-phase (or 180° out-of-phase) and minimum voltage develops when the two signals are 90° (or 270°) out-of-phase. In this type of bridge, two types of nulls can occur. One when the input signal is zero and the second when the two signals are in quadrature (90° or 270°).

3-29. The meter filter circuit and uncalibrated circuit are the same for the phase sensitive detector as for the standard voltmeter circuit. Figure 3-5 shows the feedback path for the signal amplifier. Capacitors C20 and C21 compensate for the unbalanced stray capacitance in T1.

3-30. REFERENCE CIRCUITRY.

3-31. IN-PHASE CIRCUITRY. The input reference signal is applied across the reference level control A8. After adjustment to the proper level, the reference

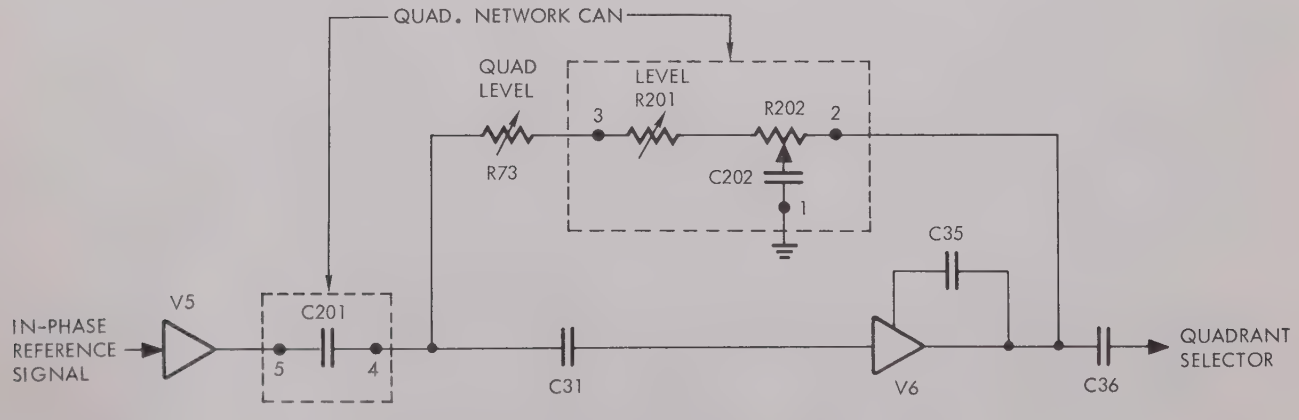


Figure 3-9. Differentiator Circuit

signal is applied to cathode follower V4. Cathode follower V4 matches impedances between the input circuit and the filters.

3-32. BAND-PASS FILTERS. As with the signal channel, one of three possible filters are selected by the frequency switch S2. The filters minimize the effects of noise and harmonics on the reference circuitry. They provide a pass band of ± 5 percent from center frequency and provide 30 db attenuation at 1/3 and three times the center frequency.

3-33. PHASING CIRCUIT. (See figure 3-7.) The reference signal from the band pass filter is applied to the phasing circuit. The amount of lead or lag introduced by the phasing control (R66) is a function of how far it is turned from its center position. When R66 is in its center position, C203 has no effect. C28 compensates for the stray capacitance from the output to ground. See figure 3-8 for the resultant vector voltage output to capacitor C29.

3-34. CATHODE FOLLOWER V5. Cathode follower V5 receives the signal from the phasing circuit and delivers the in-phase component to the quadrant selector and the input signal to the quadrature generator. The primary function of the cathode follower is isolation.

3-35. QUADRATURE GENERATOR. Amplifier V6 in conjunction with the selected quadrature network forms an operational amplifier connected as a differentiator (see figure 3-9). Since the open loop gain is very high in relation to the unity closed loop gain, the output is a negative differential of the input, or the input sine wave shifted by 270°.

3-36. Exact unity gain through the differentiator is set by adjusting the amount of feedback. A coarse level control R201 is included in each of the networks and the fine control is furnished by potentiometer R73. Resistor R202, included in the applicable network, allows a fine adjustment of the 270° output of the circuit.

3-37. PHASE ANGLE SELECTION. The phase angle of the reference voltage is selected by the combination of the quadrant selector and the calibrated phase shifter. The quadrant selector consists of two phase inverting transformers T2 and T3. The in-phase reference component is supplied directly to the phase shifter in the 0° voltage and through transformer T3 and the 180° voltage. The quadrature component is supplied directly as the 270° voltage and through transformer T2 as the 90° voltage.

3-38. Figure 3-10 shows the application of voltages to the calibrated phase shifter for selection of phase angles in the first quadrant. The 0° voltage is applied to the clockwise tap of resistor R84 and the 90° voltage applied to the counterclockwise tap. Thus every angle between 0° and 90° is available between the taps. The 180° and 270° voltages are also applied to the phase shifter and provide an overrun of the scale in conjunction with resistors R83 and R85. Resistor R86 balances the impedance of the network. For the remaining quadrants, the inputs are switched accordingly.

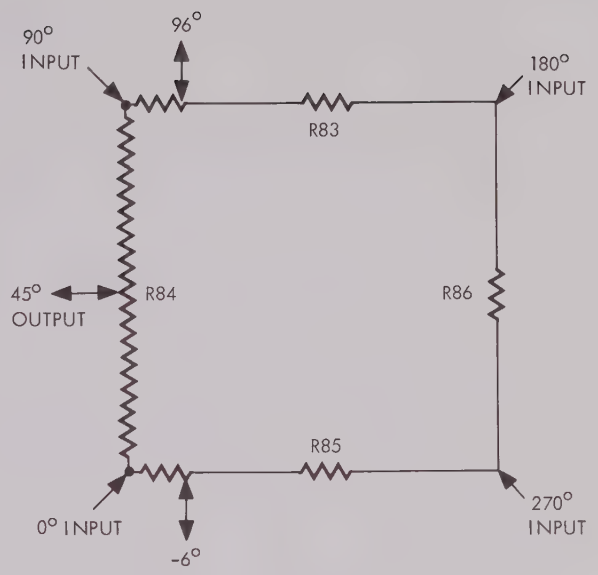


Figure 3-10. Calibrated Phase Shifter

3-39. REFERENCE AMPLIFICATION. The phase angle output of the phase shifter is amplified by isolation amplifier Q5, Q6, and Q7 and amplifier V7, and squared by amplifier V8. Diodes CR7 and CR8 provide a negative feedback path when the output signal exceeds a predetermined value. Operating voltage is only supplied to the amplifier when the unit is in the operate mode and the function switch is turned to one of the phase angle positions.

3-40. POWER SUPPLY.

3-41. The internal power supply develops six voltages as follows:

a. +290 vdc for the differentiator and the reference amplifiers.

b. +230 vdc for the in-phase reference circuitry and for signal amplifier V3.

c. +145 vdc for the input signal amplifiers.

d. 12.6 vdc heater power for V1 and V2 (in series).

e. 6.3 vac heater power for the remaining tubes, ac power lamp, and uncalibrated lamp.

f. 12.6 vac for the overload lamp.

3-43. All B + voltages are developed in full wave rectifier CR9 and a capacitor input circuit. The +145 vdc is regulated by Zener diode CR11. Rectifier CR10 develops the 12.6 vdc heater power which is biased above ground by +230 vdc.

3-44. As shown on the schematic, the unit is connected for 115 vac input power. When switch S7 is turned to the 230 vac position, the dual primaries of transformer T4 are changed from parallel to series operation.

SECTION IV
MAINTENANCE

4-1. SCHEDULED MAINTENANCE.

4-2. Once every three months, the unit should be checked for mechanical defects, such as damaged components or insulation, loose hardware, etc. Once every year the unit should be cleaned using a vacuum cleaner. No other scheduled maintenance is recommended. Refer to Section V for calibration procedures.

4-3. PARTS REPLACEMENT.

4-4. Gertsch will supply replacement components at current net prices. However, a large majority of the components are standard electronic parts, obtainable from your local electronics parts dealer. Make certain of the required tolerances by consulting the parts list, Section VI.

4-5. In replacing parts, note the following:

a. Use a 6AU6A with minimum gas for amplifier V2. If possible, select a tube which causes minimum meter transients when the VOLTS-RMS selector is changed from range to range with the input shorted.

b. If the overload diode CR4 is replaced, adjust overload circuit as outlined under OVERLOAD ADJUSTMENT in this section.

c. If the DEGREES resistor R84 is replaced, adjust control as outlined under DEGREES DIAL ADJUSTMENT in this section.

d. Whenever any electronic parts are replaced, perform the calibration test procedures as outlined in Section V.

4-6. 115/230 VAC CONVERSION.

4-7. Unless otherwise specified, the unit is wired for a 115 vac power source. To convert unit for 230 vac, proceed as follows:

a. Slide 115/230 switch to the 230 position.

b. Replace power fuse F1 with an 0.5 amp fuse.

4-8. OVERLOAD ADJUSTMENT.

4-9. To set the overload light, proceed as follows:

a. Turn FREQUENCY selector switch to any frequency channel.

b. Adjust signal generator to the selected frequency and an output of 10 volts.

c. Adjust PAV to the reference voltage as outlined in Section II.

d. Turn VOLTS-RMS switch to the 1 volt range.

e. Turn FUNCTION switch to 90°.

f. Adjust resistor R46 until the OVERLOAD lamp just starts to light.

4-10. FREQUENCY ADDITION OR CHANGE.

4-11. To add or change one of the operating frequencies proceed as follows:

a. Plug bandpass filter FL1, FL2, or FL3 into signal circuitry.

b. Plug bandpass filter FL4, FL5, or FL6 into reference circuitry.

c. Plug quadrature network Z1, Z2, or Z3 into differentiator circuitry.

d. Remove 39K feedback resistor, connected between pins 2 and 3 of the applicable quadrature networks.

NOTE

If a quadrature network is removed, install a 39 K ± 10 percent, 1/2 watt, composition resistor between pins 2 and 3 of the applicable socket.

e. Perform adjustment procedure as outlined in Section V.

4-12. DEGREES DIAL ADJUSTMENT.

4-13. To set the degrees dial proceed as follows:

a. Turn FUNCTION switch to TOTAL position.

b. Connect ohmmeter between chassis and wiper of DEGREES resistor R84.

c. Adjust DEGREES control for minimum ohmmeter reading at or near 0°.

d. Loosen the two setscrews which clamp the degree dial, rotate dial until reading is exactly 0°, and tighten the setscrews.

e. Rotate DEGREES control until minimum ohmmeter reading is obtained at or near 90°.

f. Check that minimum ohmmeter reading is obtained with DEGREES control set at 90° ± 0.1°. If not, reposition the dial to obtain the best compromise between the 0° and 90° positions.

g. Recheck 0° and 90° positions to make sure dial did not slip during tightening.

SECTION V
CALIBRATION

5-1. GENERAL.

5-2. Calibrate the Model PAV every 90 days as outlined below. The adjustments should only be performed by a qualified laboratory. Observe the following precautions:

a. Perform adjustments in the given sequence.

b. Avoid multiple ground levels (ground loops) and stray pickup.

c. Perform adjustments in a screen room for maximum accuracy.

d. Do not remove the bottom cover during calibration.

e. Leave the variable control in the CALIBRATED position.

f. Allow a 30 minute warm up.

5-3. The following test equipment, or equivalent is required:

a. Oscillator -- Hewlett-Packard, Model 201C, 20 cps to 20 kc.

d. Differential AC VTVM -- John Fluke, Model 803D ± 0.3 percent or better, 50 cps to 20 kc.

c. AC Ratio Standard -- Gertsch, Model 1011, 0.35f, 0 to 1.1111.

d. Isolation Transformer -- Gertsch, Model ST-102 (PAV-1A only).

e. Counter -- Hewlett-Packard, Model 521A.

5-4 FILTER INSERTION LOSS.

5-5. If the Model PAV is equipped with more than one frequency, balance the filter insertion losses as follows:

a. Connect the PAV into the test setup as shown in figure 5-1.

b. Adjust the oscillator for 10 volts output at the lowest operating frequency.

c. Turn R27, R29, and R31 fully counterclockwise as viewed from the top.

d. Set the VOLTS-RMS switch to the 0.3 volt scale.

e. Place the MODE switch in the OPR position.

f. Set the FREQUENCY switch to the lowest operating frequency.

g. Set the FUNCTION switch to FUND.

TABLE 3. SELECTED TEST COMPONENTS

OPERATING FREQUENCY (CPS)	TEST CAPACITOR (MFD)
50	.032
60	.027
100	.016
135	.012
400	.004
500	.0032
800	.002
1000	.0016
1200	.0013
1600	.001
1800	.00089
2000	.0008
2400	.00066
3000	.00053
3200	.0005
3600	.00044
4500	.00035
4800	.00033
5000	.00032
6400	.00025
7200	.00022
10000	.00016
20000	.00008

$$C(ufd) = \frac{1.6}{f(cps)}$$

h. Adjust the AC Ratio Standard for 90 percent of full scale on the PAV.

i. Change the frequency of the PAV and the oscillator to the next highest operating frequency.

j. Note the reading on the PAV.

k. Repeat i and j above if a third frequency is included.

l. Determine from h, j, and k above which two frequencies give the highest indications, and adjust their corresponding trimpots R27, R29, and R31, above for equal indication at each frequency.

5-6. SIGNAL AMPLIFIER ADJUSTMENT.

5-7. Calibrate the signal amplifier as follows:

a. Adjust the PAV as outlined in steps a through e of paragraph 5-5.

b. Connect PAV into the test setup shown in figure 5-2. Set the test switch S1 to 0°. The resistor and capacitor are not required at this time.

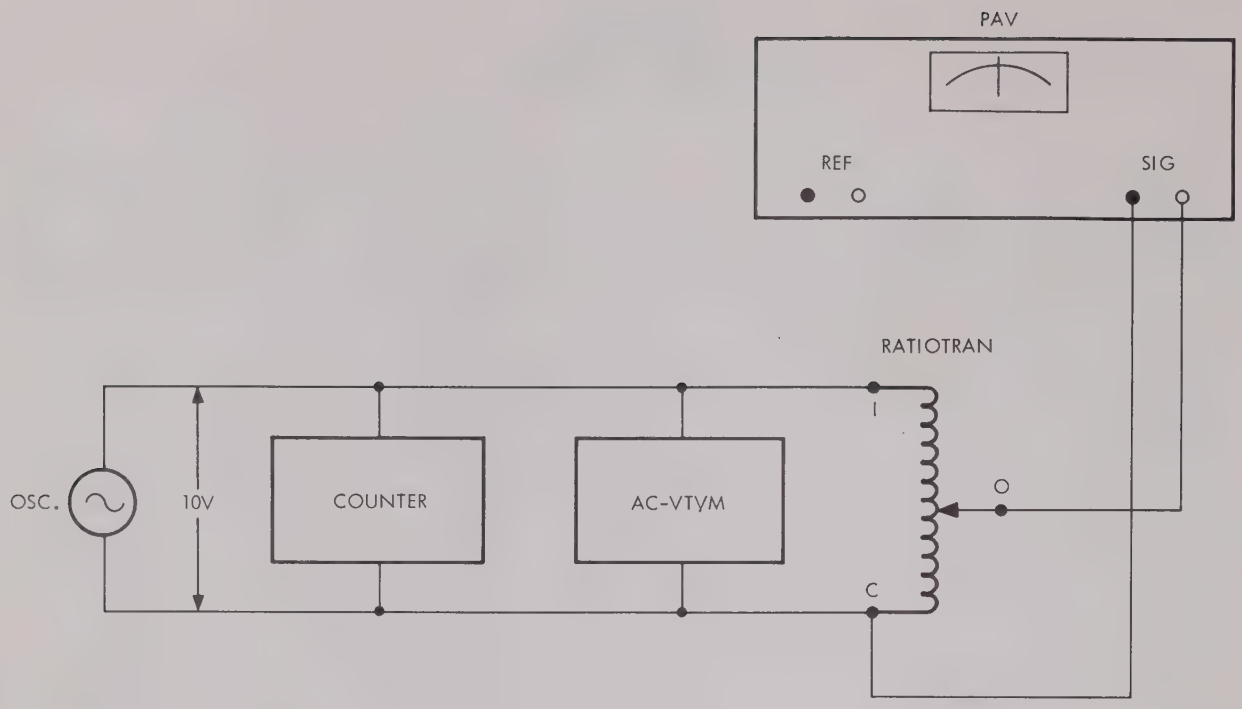


Figure 5-1. Voltmeter Test Setup

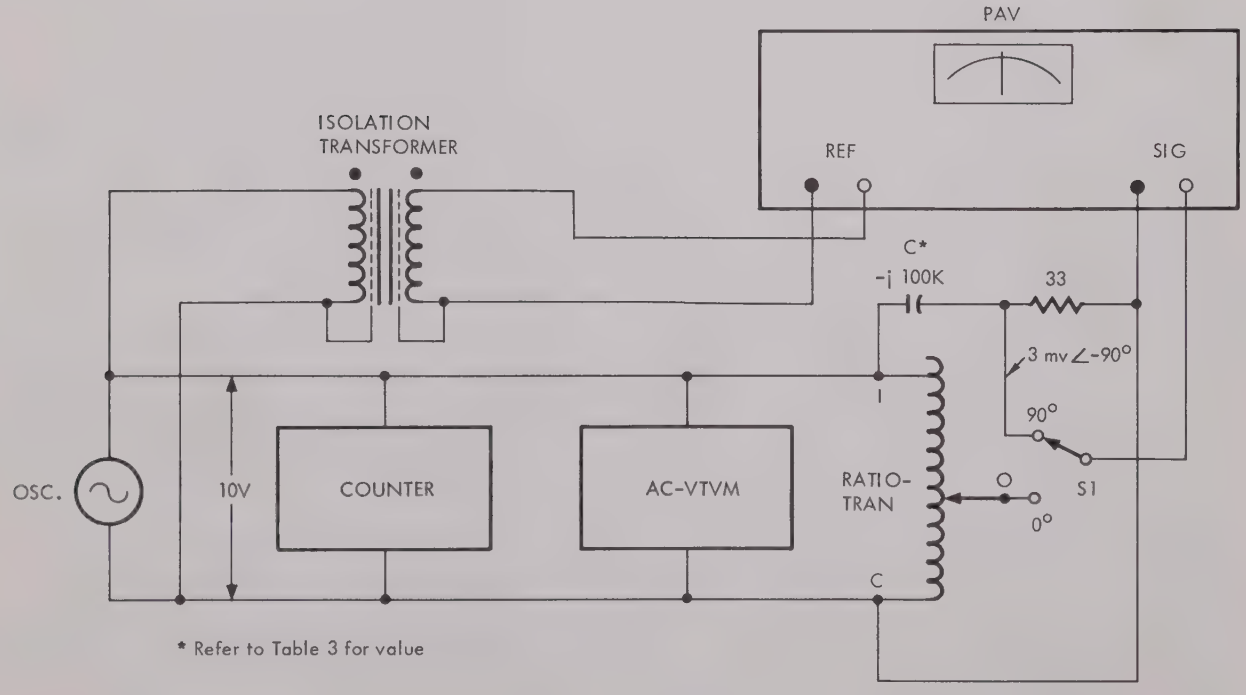


Figure 5-2. Phase Angle Voltmeter Test Setup

c. Adjust oscillator for 10 volts output at one of the PAV operating frequencies.

d. Set AC Ratio Standard to a ratio of 0.030 (0.3v).

e. Turn MODE switch to REF LEVEL and adjust REF LEVEL control until the meter indicates the proper value.

f. Turn MODE switch to QUAD LEVEL and adjust QUADRATURE LEVEL control until the meter indicates the same value as in e above.

g. Turn MODE switch to OPR.

h. Set DEGREES dial to 0°.

i. Turn FUNCTION switch to 90°.

j. Adjust PHASING control for an exact null on the meter.

k. Turn FUNCTION switch to 0°.

l. Adjust resistor R36 to obtain a full scale deflection of the meter.

m. Turn FUNCTION switch to FUND.

n. Adjust resistor R47 to obtain a full scale deflection of the meter.

o. Turn FUNCTION switch to TOTAL.

p. Adjust resistor R38 to obtain a full scale deflection of the meter.

5-8. QUADRATURE NETWORK ADJUSTMENT.

5-9. Adjust the course quadrature level control R201 as follows:

a. Connect the PAV into the test setup shown in figure 5-2.

b. Adjust oscillator for 10 volt output at the lowest operating frequency.

c. Turn MODE switch to REF LEVEL.

d. Adjust REFERENCE LEVEL control to set meter deflection to the REF level mark.

e. Turn MODE switch to QUAD LEVEL.

f. Adjust QUADRATURE LEVEL control set meter deflection to the REF level mark.

g. Check that the QUADRATURE LEVEL control is set to approximately the midpoint of its range. If not, set control to the midpoint and set meter deflection to the REF level mark with coarse control R201.

h. Repeat procedure for remaining frequencies.

5-10. Adjust 270° control R202 as follows:

a. At completion of the coarse level control adjustment, turn MODE switch to OPR.

b. Turn FUNCTION switch to 0°.

c. Turn VOLTS-RMS switch to the 0.003v scale.

d. Set test switch S1 to 90°.

e. Adjust PHASING control to obtain an exact null on the meter.

f. Turn FUNCTION switch to 90°.

g. Set test switch S1 to 0°.

h. Set AC Ratio Standard to a ratio of 0.0003 (3 mv).

i. Adjust 270° control R202 to obtain an exact null on the meter.

j. Repeat procedure for remaining frequencies.

5-11. INPUT ATTENUATOR ADJUSTMENTS.

5-12. Adjust low frequency response of the input attenuator as follows:

a. At the completion of the 270° control adjustment, turn test switch S1 to 0°.

b. Turn FUNCTION switch to TOTAL.

c. Turn VOLTS-RMS switch to the 0.01 scale.

d. Adjust AC Ratio Standard to obtain an exactly full scale deflection of the meter (ratio of approximately 0.001).

e. Turn FUNCTION switch to 90°.

f. Adjust PHASING for an exact null on the meter.

g. Turn VOLT-RMS switch to the 10 volt scale.

h. Set AC Ratio Standard to exactly 1000 times the ratio set in step d.

i. Adjust capacitor C2 until the meter moves approximately half the distance toward null.

j. Turn FUNCTION switch to TOTAL.

k. Adjust potentiometer R3 until the meter moves approximately half the distance towards full scale.

l. Repeat steps i through k until an exact null is obtained with the FUNCTION switch in the 90° position and an exact full scale indication is obtained with the FUNCTION switch in the TOTAL position.

5-13. OVERLOAD ADJUSTMENT

5-14. Adjust overload circuit as outlined in paragraph 4-8.

c. Adjust oscillator for 10 volts output at one of the PAV operating frequencies.

d. Set AC Ratio Standard to a ratio of 0.030 (0.3v).

e. Turn MODE switch to REF LEVEL and adjust REF LEVEL control until the meter indicates the proper value.

f. Turn MODE switch to QUAD LEVEL and adjust QUADRATURE LEVEL control until the meter indicates the same value as in e above.

g. Turn MODE switch to OPR.

h. Set DEGREES dial to 0°.

i. Turn FUNCTION switch to 90°.

j. Adjust PHASING control for an exact null on the meter.

k. Turn FUNCTION switch to 0°.

l. Adjust resistor R36 to obtain a full scale deflection of the meter.

m. Turn FUNCTION switch to FUND.

n. Adjust resistor R47 to obtain a full scale deflection of the meter.

o. Turn FUNCTION switch to TOTAL.

p. Adjust resistor R38 to obtain a full scale deflection of the meter.

5-8. QUADRATURE NETWORK ADJUSTMENT.

5-9. Adjust the course quadrature level control R201 as follows:

a. Connect the PAV into the test setup shown in figure 5-2.

b. Adjust oscillator for 10 volt output at the lowest operating frequency.

c. Turn MODE switch to REF LEVEL.

d. Adjust REFERENCE LEVEL control to set meter deflection to the REF level mark.

e. Turn MODE switch to QUAD LEVEL.

f. Adjust QUADRATURE LEVEL control set meter deflection to the REF level mark.

g. Check that the QUADRATURE LEVEL control is set to approximately the midpoint of its range. If not, set control to the midpoint and set meter deflection to the REF level mark with coarse control R201.

h. Repeat procedure for remaining frequencies.

5-10. Adjust 270° control R202 as follows:

a. At completion of the coarse level control adjustment, turn MODE switch to OPR.

b. Turn FUNCTION switch to 0°.

c. Turn VOLTS-RMS switch to the 0.003v scale.

d. Set test switch S1 to 90°.

e. Adjust PHASING control to obtain an exact null on the meter.

f. Turn FUNCTION switch to 90°.

g. Set test switch S1 to 0°.

h. Set AC Ratio Standard to a ratio of 0.0003 (3 mv).

i. Adjust 270° control R202 to obtain an exact null on the meter.

j. Repeat procedure for remaining frequencies.

5-11. INPUT ATTENUATOR ADJUSTMENTS.

5-12. Adjust low frequency response of the input attenuator as follows:

a. At the completion of the 270° control adjustment, turn test switch S1 to 0°.

b. Turn FUNCTION switch to TOTAL.

c. Turn VOLTS-RMS switch to the 0.01 scale.

d. Adjust AC Ratio Standard to obtain an exactly full scale deflection of the meter (ratio of approximately 0.001).

e. Turn FUNCTION switch to 90°.

f. Adjust PHASING for an exact null on the meter.

g. Turn VOLT-RMS switch to the 10 volt scale.

h. Set AC Ratio Standard to exactly 1000 times the ratio set in step d.

i. Adjust capacitor C2 until the meter moves approximately half the distance toward null.

j. Turn FUNCTION switch to TOTAL.

k. Adjust potentiometer R3 until the meter moves approximately half the distance towards full scale.

l. Repeat steps i through k until an exact null is obtained with the FUNCTION switch in the 90° position and an exact full scale indication is obtained with the FUNCTION switch in the TOTAL position.

5-13. OVERLOAD ADJUSTMENT

5-14. Adjust overload circuit as outlined in paragraph 4-8.

c. Adjust oscillator for 10 volts output at one of the PAV operating frequencies.

d. Set AC Ratio Standard to a ratio of 0.030 (0.3v).

e. Turn MODE switch to REF LEVEL and adjust REF LEVEL control until the meter indicates the proper value.

f. Turn MODE switch to QUAD LEVEL and adjust QUADRATURE LEVEL control until the meter indicates the same value as in e above.

g. Turn MODE switch to OPR.

h. Set DEGREES dial to 0°.

i. Turn FUNCTION switch to 90°.

j. Adjust PHASING control for an exact null on the meter.

k. Turn FUNCTION switch to 0°.

l. Adjust resistor R36 to obtain a full scale deflection of the meter.

m. Turn FUNCTION switch to FUND.

n. Adjust resistor R47 to obtain a full scale deflection of the meter.

o. Turn FUNCTION switch to TOTAL.

p. Adjust resistor R38 to obtain a full scale deflection of the meter.

5-8. QUADRATURE NETWORK ADJUSTMENT.

5-9. Adjust the course quadrature level control R201 as follows:

a. Connect the PAV into the test setup shown in figure 5-2.

b. Adjust oscillator for 10 volt output at the lowest operating frequency.

c. Turn MODE switch to REF LEVEL.

d. Adjust REFERENCE LEVEL control to set meter deflection to the REF level mark.

e. Turn MODE switch to QUAD LEVEL.

f. Adjust QUADRATURE LEVEL control set meter deflection to the REF level mark.

g. Check that the QUADRATURE LEVEL control is set to approximately the midpoint of its range. If not, set control to the midpoint and set meter deflection to the REF level mark with coarse control R201.

h. Repeat procedure for remaining frequencies.

5-10. Adjust 270° control R202 as follows:

a. At completion of the coarse level control adjustment, turn MODE switch to OPR.

b. Turn FUNCTION switch to 0°.

c. Turn VOLTS-RMS switch to the 0.003v scale.

d. Set test switch S1 to 90°.

e. Adjust PHASING control to obtain an exact null on the meter.

f. Turn FUNCTION switch to 90°.

g. Set test switch S1 to 0°.

h. Set AC Ratio Standard to a ratio of 0.0003 (3 mv).

i. Adjust 270° control R202 to obtain an exact null on the meter.

j. Repeat procedure for remaining frequencies.

5-11. INPUT ATTENUATOR ADJUSTMENTS.

5-12. Adjust low frequency response of the input attenuator as follows:

a. At the completion of the 270° control adjustment, turn test switch S1 to 0°.

b. Turn FUNCTION switch to TOTAL.

c. Turn VOLTS-RMS switch to the 0.01 scale.

d. Adjust AC Ratio Standard to obtain an exactly full scale deflection of the meter (ratio of approximately 0.001).

e. Turn FUNCTION switch to 90°.

f. Adjust PHASING for an exact null on the meter.

g. Turn VOLT-RMS switch to the 10 volt scale.

h. Set AC Ratio Standard to exactly 1000 times the ratio set in step d.

i. Adjust capacitor C2 until the meter moves approximately half the distance toward null.

j. Turn FUNCTION switch to TOTAL.

k. Adjust potentiometer R3 until the meter moves approximately half the distance towards full scale.

l. Repeat steps i through k until an exact null is obtained with the FUNCTION switch in the 90° position and an exact full scale indication is obtained with the FUNCTION switch in the TOTAL position.

5-13. OVERLOAD ADJUSTMENT

5-14. Adjust overload circuit as outlined in paragraph 4-8.

SECTION VI
PARTS LIST

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
A1	6-3	Board Assy, Signal Input (See figure 6-5.)	Gertsch	AA-1100
A2	6-3	Board Assy, Quadrature generator (See figure 6-6.)	Gertsch	AA-1099
A3	6-3	Board Assy, Reference amplifier (See figure 6-7.)	Gertsch	AA-1105
A4	6-4	Board Assy, Power supply (See figure 6-8.)	Gertsch	AA-1097
A5	6-3	Board Assy, Signal amplifier (See figure 6-9.)	Gertsch	AA-1104
A6	6-3	Board Assy, Reference input (See figure 6-10.)	Gertsch	AA-1098
A7	6-3	Board Assy, Phase detector, See figure (6-11.)	Gertsch	AA-1102
A8	6-1	Reference Level Assy (See figure 6-14.)	Gertsch	AA-1143
A9	6-4	Board Assy, Diodes (See figure 6-12.)	Gertsch	AW-1141
A10		Board Assy, Isolation amplifier (See figure 6-13.)	Gertsch	AA-1246
CR1	6-9	Diode, silicon	Texas Instrument	1N914
CR2	6-9	Diode, silicon	Texas Instrument	1N914
CR3	6-9	Diode, silicon	Texas Instrument	1N914
CR4	6-9	Diode, SCR	Transitron	SW1444
CR5	6-11	Diode, silicon	Texas Instrument	1N914
CR6	6-11	Diode, silicon	Texas Instrument	1N914
CR7	6-7	Diode, silicon	Texas Instrument	1N914
CR8	6-7	Diode, silicon	Texas Instrument	1N914
CR9	6-8	Diode Bridge	Semtech	SB6
CR10	6-8	Diode Bridge	Semtech	SB1
CR11	6-3	Zener Diode, 145V	Hoffman	1N1812A
CR12	6-12	Diode, silicon	Texas Instrument	1N914
CR13	6-12	Diode, silicon	Texas Instrument	1N914
CR14	6-4	Diode, silicon	Texas Instrument	1N914
CR15	6-4	Diode, silicon	Texas Instrument	1N914
CR16		Diode, Zener, 12V		1N716
CR17		Diode, Zener, 12V		1N716
C1	6-3	Capacitor, mylar, 0.047 uf, 600 vdc	Reliable Cap.	VT473M6A

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
C2	6-3	Capacitor, trimmer, 3 to 12 pf	Erie	503NP03-12
C3	6-3	Capacitor, mica, 0.0043 uf, 500 vdc	Elmenco	DM20E432J
C4	6-3	Capacitor, mylar, 0.047 uf, 600 vdc	Reliable Cap.	VT473M6A
C5	6-5	Capacitor, electrolytic, 12 uf, 150 vdcw	Sprague	TE1508
C6	6-5	Capacitor, mylar, 9 uf, 200 vdcw	Reliable Cap.	RC193
C7	6-9	Capacitor, electrolytic, 12 uf, 150 vdcw	Sprague	TE1508
C8	6-9	Capacitor, electrolytic, 12 uf, 150 vdcw	Sprague	TE1508
C9	6-9	Capacitor, mylar, 0.5 uf ±20%, 200 vdcw	Reliable Cap.	VMF504M2A
C10	6-9	Capacitor, electrolytic, 300 uf, 6 vdcw	Nashville Elec	12-500BP300-6S65
C11	6-9	Capacitor, paper, 0.25 uf, 200 vdc	Hopkins	P252D
C12	6-9	Capacitor, electrolytic, 5 uf, 15 vdcw	Nashville Elec	11-215BP5-15D65
C13	6-9	Capacitor, electrolytic, 12 uf, 150 vdcw	Sprague	TE1508
C14	6-9	Capacitor, mylar, 4 uf, 200 vdc	Reliable Cap.	VMT405-M2P
C15	6-9	Capacitor, mylar, 1 uf, 200 vdc	Hopkins	1P2M
C16	6-9	Capacitor, electrolytic, 5 uf, 15 vdcw	Nashville Elec	11-215BP5-15D65
C17	6-9	Capacitor, ceramic disc, 0.015 uf nominal value	Elmenco	1DP-1-153
C18	6-11	Capacitor, mica, 15 pf	Elmenco	DM15E150J
C19	6-11	Capacitor, mica, 15 pf	Elmenco	DM15E150J
C20	6-11	Capacitor, trimmer, 12 to 60 pf	Erie	538-006-P3P0-112R
C21	6-11	Capacitor, trimmer, 12 to 60 pf	Erie	538-006-P3P0-112R
C22	6-11	Capacitor, electrolytic, 2 uf, 3 vdc	Nashville Elec	12-375BP2-3S65NP
C23	6-11	Capacitor, electrolytic, 2 uf, 3 vdc	Nashville Elec	12-375BP2-3S65NP
C24	6-11	Capacitor, electrolytic, 50 uf, 3 vdcw	Nashville Elec	10-375BP50-3S65NP
C25	6-3	Capacitor, paper, 0.1 uf, 600 vdc	Sprague	6TM-P10
C26	6-10	Capacitor, paper, 0.05 uf, 200 vdcw	Aerovox	P829ZN9
C27	6-10	Capacitor, mylar, 9 uf, 200 vdcw	Reliable Cap.	RC193
C28	6-10	Capacitor, mica, 47 pf nominal value	Elmenco	DM15E470J
C29	6-10	Capacitor, paper, 0.05 uf, 200 vdcw	Aerovox	P829ZN9
C30	6-10	Capacitor, mylar, 4 uf, 200 vdcw	Reliable Cap.	VMT405M2P

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
C31	6-6	Capacitor, paper, 0.05 uf, 200 vdcw	Aerovox	P829ZN9
C32	6-6	Capacitor, mica, 220 pf, 200 vdc	Elmenco	DM15E221J
C33	6-6	Capacitor, electrolytic, 300 uf, 6 vdcw	Nashville Elec	12-500BP300-6S65
C34	6-6	Capacitor, electrolytic, 12 uf, 150 vdcw	Sprague	TE1508
C35	6-6	Capacitor, electrolytic, 50 uf, 350 vdcw	Sprague	TVL1622
C36	6-6	Capacitor, mylar, 4 uf, 200 vdcw	Reliable Cap.	VMT405M2P
C37	6-7	Capacitor, paper, 0.05 uf, 200 vdc	Aerovox	P829ZN9
C38	6-7	Capacitor, dual, 30 uf ea sect., 350 vdcw	Sprague	TVL2628
C39	6-7	Capacitor, mylar, 4 uf, 200 vdcw	Reliable Cap.	VMT405M2P
C40	6-7	Capacitor, mica, 24 pf nominal value	Elmenco	DM15E240J
C41	6-7	Capacitor, electrolytic, 300 uf, 6 vdcw	Sprague	TE1106
C42	6-7	Capacitor, electrolytic, 12 uf, 150 vdcw	Sprague	TE1508
C43	6-7	Capacitor, mylar, 4 uf, 200 vdcw	Reliable Cap.	VMT405M2P
C44	6-7	Capacitor, mylar, 4 uf, 200 vdcw	Reliable Cap.	VMT405M2P
C45	6-3	Capacitor, electrolytic, 3 section, 20 uf ea sect., 450 vdcw	Sprague	TVL3780
C46	6-3	Capacitor, electrolytic, 2000 uf, 15 vdcw	Nashville Elec	32-1.000BP2000-15S65TL
C47	6-3	Capacitor, electrolytic, 2000 uf, 15 vdcw	Nashville Elec	32-1.000BP2000-15S65TL
C48	6-8	Capacitor, electrolytic, 5 uf, 150 vdcw	Sprague	TE1504
C49	6-8	Capacitor, mylar, 0.5 uf, 200 vdc	Reliable Cap.	VMF504M2A
C50	6-12	Capacitor, mylar, 0.5 uf, 200 vdc	Reliable Cap.	VMF504M2A
C51		Capacitor, mylar, 0.5 uf, 200 vdc	Reliable Cap.	VMF504M2A
C52		Capacitor, mica, 10 pf ±5%	Elmenco	DM15E100J
DS1	6-1	Light, Indicator	Sloan Co.	105S-W-F2
DS2	6-1	Light, Indicator	Sloan Co.	105S-A-F2
DS3	6-1	Light, Indicator	Sloan Co.	105S-R-F2
F1	6-2	Fuse, 115V operation, 1 amp	Bussmann	MDL1
F1	6-2	Fuse, 230V operation, 0.5 amp	Bussmann	MDL1-2
FL1	6-6	Filter	Gertsch	EP-58 (freq)
FL2	6-6	Filter	Gertsch	EP-58 (freq)
FL3	6-6	Filter	Gertsch	EP-58 (freq)
FL4	6-6	Filter	Gertsch	EP-59 (freq)

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
FL5	6-6	Filter	Gertsch	EP-59 (freq)
FL6	6-6	Filter	Gertsch	EP-59 (freq)
J1	6-1	Post, Binding, red	Superior	DF30RC
J2	6-1	Post, Binding, black	Superior	DF30BC
J3	6-2	Post, Binding, red	Superior	DF30RC
J4	6-2	Post, Binding, black	Superior	DF30BC
J5	6-1	Post, Binding, red	Superior	DF30RC
J6	6-1	Post, Binding, black	Superior	DF30BC
J7	6-2	Post, Binding, red	Superior	DF30RC
J8	6-2	Post, Binding, black	Superior	DF30BC
J10	6-2	Banana Jack, red	Johnson	108-902
J11	6-2	Banana Jack, black	Johnson	108-903
J12	6-2	Post, Binding, white	Superior	DF30WTC
M1	6-1	Meter	Gertsch	MA18
P1	6-2	P/O Power Cord	Belden	17406S
		Adapter Plug	Cornish	228
Q1	6-11	Transistor, PNP, germanium	Gen Instr Corp	2N417
Q2	6-11	Transistor, PNP, germanium	Gen Instr Corp	2N417
Q3	6-11	Transistor, PNP, germanium	Gen Instr Corp	2N417
Q4	6-11	Transistor, PNP, germanium	Gen Instr Corp	2N417
Q5		Transistor	GE	2N2924
Q6		Transistor	GE	2N2924
Q7		Transistor	GE	2N2924
R1	6-3	Resistor, metal oxide, 20 meg ±1%, 1/2W		RN20X2005F
R2	6-3	Resistor, metal oxide, 17.8K ±1%, 1/2W		RN70B1782F
R3	6-3	Potentiometer, 5K, 1/2W	Bourns	3067S-5K
R4	6-5	Resistor, comp, 470 ohms ±10%, 1/4W		
R5	6-5	Resistor, comp, 2.2 meg ±10%, 1/4W		
R6	6-5	Resistor, comp, 10K ±10%, 1/4W		
R7	6-5	Resistor, comp, 1.2K ±10%, 1/2W		
R8	6-5	Resistor, comp, 47K ±10%, 1/4W		
R9	6-5	Resistor, comp, 10K ±10%, 1/4W		
R10	6-3	Resistor, wire wound, 1550 ohms ±0.25%	Gertsch	EP-64-1

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
R11	6-3	Resistor, wire wound, 2550 ohms ±0.25%	Gertsch	EP-64-2
R12	6-3	Resistor, wire wound, 1000 ohms ±0.25%	Gertsch	EP-64-3
R13	6-3	Resistor, wire wound, 1500 ohms ±0.25%	Gertsch	EP-64-4
R14	6-3	Resistor, wire wound, 3186.4 ohms ±0.25%	Gertsch	EP-64-5
R15	6-3	Resistor, wire wound, 1636.4 ohms ±0.25%	Gertsch	EP-64-6
R16	6-3	Resistor, wire wound, 404.04 ohms ±0.25%	Gertsch	EP-64-7
R17	6-3	Resistor, wire wound, 3421.0 ohms ±0.25%	Gertsch	EP-64-8
R18	6-3	Resistor, wire wound, 1871.0 ohms ±0.25%	Gertsch	EP-64-9
R19	6-3	Resistor, wire wound, 133.48 ohms ±0.25%	Gertsch	EP-64-10
R20	6-3	Resistor, wire wound, 3510.4 ohms ±0.25%	Gertsch	EP-64-11
R21	6-3	Resistor, wire wound, 1960.4 ohms ±0.25%	Gertsch	EP-64-12
R22	6-3	Resistor, wire wound, 40.004 ohms ±0.25%	Gertsch	EP-64-13
R23	6-3	Resistor, wire wound, 3541.7 ohms ±0.25%	Gertsch	EP-64-14
R24	6-3	Resistor, wire wound, 1986.7 ohms ±0.25%	Gertsch	EP-64-15
R25	6-3	Resistor, wire wound, 13.333 ohms ±0.25%	Gertsch	EP-64-16
R26	6-6	Resistor, comp, 47K ±10%, 1/4W		
R27	6-6	Potentiometer, 5K ±10%	CTS	37097
R28	6-6	Resistor, comp, 47K ±10%, 1/4W		
R29	6-6	Potentiometer, 5K ±10%	CTS	37097
R30	6-6	Resistor, comp, 47K ±10%, 1/4W		
R31	6-6	Potentiometer, 5K ±10%	CTS	37097
R32	6-9	Resistor, comp, 680K ±10%, 1/4W		
R33	6-9	Resistor, comp, 220K ±10%, 1/4W		
R34	6-9	Resistor, comp, 10K ±10%, 1/4W		
R35	6-9	Resistor, comp, 1.2K ±10%, 1/4W		
R36	6-9	Potentiometer, wire wound, 50 ohms ±10%	CTS	BL37418
R37	6-9	Resistor, wire wound, 51 ohms ±5%	IRC	BWH51
R38	6-9	Potentiometer, wire wound, 50 ohms ±10%	CTS	BL37418
R39	6-9	Resistor, comp, 10 ohms ±10%, 1/4W		
R40	6-9	Resistor, comp, 100 ohms ±10%, 1/4W		
R41	6-9	Resistor, comp, 270K ±10%, 1/4W		
R42	6-9	Resistor, comp, 470K ±10%, 1/4W		
R43	6-9	Resistor, comp, 1 meg ±10%, 1/4W		

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
R44	6-9	Resistor, comp, 10K ±10%, 1/4W		
R45	6-9	Resistor, comp, 680K ±10%, 1/4W		
R46	6-9	Potentiometer, comp, 25K ±10%	CTS	36995
R47	6-9	Potentiometer, wire wound, 50 ohms ±10%	CTS	BL37418
R48	6-9	Resistor, comp, 100K ±10%, 1/4W		
R49	6-9	Resistor, comp, 4.7K ±10%, 1/4W		
R50	6-9	Resistor, comp, 47K ±10%, 1/4W		
R51	6-9	Resistor, wire wound, 62 ohms ±5%	IRC	BWH62
R52	6-9	Resistor, comp, 100 ohms nominal value		
R53	6-11	Resistor, comp, 22K ±10%, 1/4W		
R54	6-11	Resistor, comp, 22K ±10%, 1/4W		
R55 thru R58	6-11	Resistor, metal oxide, 10K ±2%, 1/4W	Corning	C07-10,000G
R59	6-1	Potentiometer, 10K ±20%	CTS	37254
R60	6-11	Resistor, comp, 3.3K ±10%, 1/4W		
R62	6-10	Resistor, comp, 470 ohms ±10%, 1/4W		
R63	6-10	Resistor, comp, 2.2 meg ±10%, 1/4W		
R64	6-10	Resistor, comp, 1.2K ±10%, 1/4W		
R65	6-10	Resistor, comp, 47K ±10%, 1/2W		
R66	6-1	Potentiometer, 50K	CTS	52867
R67	6-10	Resistor, comp, 100K ±10%, 1/4W		
R68	6-10	Resistor, comp, 100K ±10%, 1/4W		
R69	6-10	Resistor, comp, 470 ohms ±10%, 1/4W		
R70	6-10	Resistor, comp, 2.2 meg ±10%, 1/4W		
R71	6-10	Resistor, comp, 1.2K ±10%, 1/4W		
R72	6-10	Resistor, comp, 47K ±10%, 1/2W		
R73	6-1	Potentiometer, 5K ±20%	CTS	37641
R74	6-6	Resistor, comp, 1 meg ±10%, 1/2W		
R75	6-6	Resistor, comp, 47K ±10%, 1W		
R76	6-6	Resistor, comp, 22K ±10%, 1/2W		
R77	6-6	Resistor, comp, 680 ohms ±10%, 1/4W		
R78	6-6	Resistor, comp, 68K ±10%, 1W		

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
R79	6-6	Resistor, comp, 1K ±10%, 1/2W		
R80	6-6	Resistor, comp, 10K ±10%, 1/4W		
R81	6-6	Resistor, comp, 56K ±10%, 1W		
R82	6-6	Resistor, comp, 22K ±10%, 1W		
R83	6-7	Resistor, metal film, 45.3K ±1%, 1/8W		RN60B4532F
R84	6-1	Potentiometer, 60K	Gertsch	RV-64
R85	6-7	Resistor, metal film, 45.3K ±1%, 1/8W		RN60B4532F
R86	6-7	Resistor, comp, 47K ±10%, 1/2W		
R87	6-7	Resistor, comp, 2.2 meg ±10%, 1/4W		
R88	6-7	Resistor, comp, 4.7K ±10%, 1/2W		
R89	6-7	Resistor, comp, 47K ±10%, 1W		
R90	6-7	Resistor, comp, 1.2K ±10%, 1/4W		
R91	6-7	Resistor, comp, 150 ohms ±10%, 1/4W		
R92	6-7	Resistor, comp, 100K ±10%, 1/4W		
R93	6-7	Resistor, comp, 68K ±10%, 1W		
R94		Not Used		
R95	6-7	Resistor, comp, 620 ohms ±5%, 1/2W		
R96	6-7	Resistor, comp, 68K ±10%, 1W		
R97	6-7	Resistor, comp, 1K ±10%, 1/4W		
R98	6-7	Resistor, comp, 56K ±10%, 1W		
R99	6-7	Resistor, comp, 1K ±10%, 1/2W		
R100	6-7	Resistor, comp, 10K ±10%, 2W		
R101	6-7	Resistor, comp, 1.2K ±10%, 1/2W		
R102	6-3	Resistor, wire wound, 2.5K ±10%, 10W	Tru-ohm	MOR-10-2500
R103	6-8	Resistor, comp, 5.6K ±10%, 2W		
R104	6-8	Resistor, comp, 220K ±10%, 1/2W		
R105	6-8	Resistor, comp, 3.3 ohms ±10%, 1W		
R106	6-4	Resistor, wire wound, 10K ±10%, 10W	Tru-ohm	MOR-10-10K
R107	6-8	Resistor, comp, 100K ±10%, 1/2W		
R108	6-4	Resistor, comp, 27 ohms ±10%, 1/2W		
R109	6-3	Resistor, comp, 27 ohms ±10%, 1/2W		
R110	6-3	Resistor, comp, 27 ohms ±10%, 1/2W		

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
#R111		Resistor, comp, nominal value 50K or more		
#R112		Resistor, comp, nominal value 50K or more		
R113		Not Used		
R114	6-9	Resistor, wire wound, 125 ohms ±1%, 1/4W	Dalohm	RS-1A
R115	6-12	Resistor, comp, 220 ohms ±10%, 1/2W		
R116		Resistor, comp, 1 meg ±10%, 1/4W		
R117		Resistor, comp, 1 meg ±10%, 1/4W		
R118		Resistor, comp, 12K ±10%, 1/4W		
R119		Resistor, comp, 100 ohms ±10%, 1/4W		
R120		Resistor, comp, 10K ±10%, 1/4W		
R121		Resistor, comp, 2.2K ±10%, 1/4W		
R122		Resistor, comp, 33K ±10%, 2W		
S1	6-1	Switch, rotary	Gertsch	SW-257
S2	6-1	Switch, rotary	Gertsch	SW-271
S3	6-1	Switch, rotary (Part of S2)		
S4	6-1	Switch, rotary	Gertsch	SW-264
S5	6-1	Switch, rotary (Part of R59)		
S6	6-1	Switch (Part of R66)		
S7	6-3	Switch, slide	Muter	4633
T1	6-11	Transformer	Gertsch	TA-434
T2	6-4	Transformer	Gertsch	TA-293-1
T3	6-4	Transformer	Gertsch	TA-293-1
T4	6-3	Transformer	Gertsch	TP-18A
V1	6-5	Tube, electron		6AU6A
V2	6-9	Tube, electron		6AU6A
V3	6-9	Tube, electron		6U8A
V4	6-10	Tube, electron		6AU6A
V5	6-10	Tube, electron		6AU6A
V6	6-6	Tube, electron		6U8A
V7	6-7	Tube, electron		6AU6A
V8	6-7	Tube, electron		6U8A
Z1	6-6	Network, quadrature	Gertsch	EP60 (freq)

Balancing resistors. Normally only resistor is used.

SYMBOL	FIGURE	DESCRIPTION	MANUFACTURER	PART NO.
Z2	6-6	Network, quadrature	Gertsch	EP60 (freq)
Z3	6-6	Network, quadrature	Gertsch	EP60 (freq)
XCR4		Socket	Ind Electronic Hdw Corp	MPT0603-1
XF1		Fuseholder	Littelfuse	342004
XFL1 thru XFL6		Socket, 7 pin	Methode	P455
XQ1 thru XQ4		Socket, transistor	Ind Electronic Hdw Corp	MPT0603-1
XV1		Socket, tube, 7 pin	Methode	P455
XV2		Socket, tube, 7 pin	Methode	P455
XV3		Socket, tube, 9 pin	Methode	P465
XV4		Socket, tube, 7 pin	Methode	P455
XV5		Socket, tube, 7 pin	Methode	P455
XV6		Socket, tube, 9 pin	Methode	P465
XV7		Socket, tube, 7 pin	Methode	P455
XV8		Socket, tube, 9 pin	Methode	P465
XZ1 thru XZ3		Socket, 7 pin	Methode	P455
		Shield, tube (V1, V2, V4, V5, V7)	Coolfin	CFT-5-L-D
		Shield, tube (V3, V6, V8)	Coolfin	CFT-6-L-D

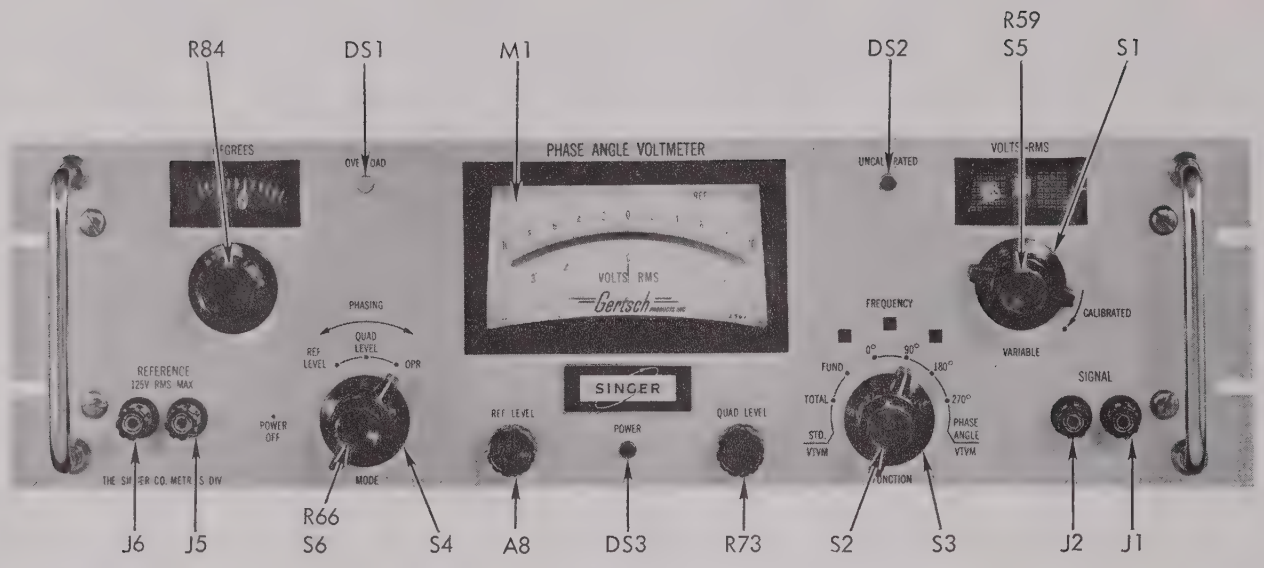


Figure 6-1. Front Panel View

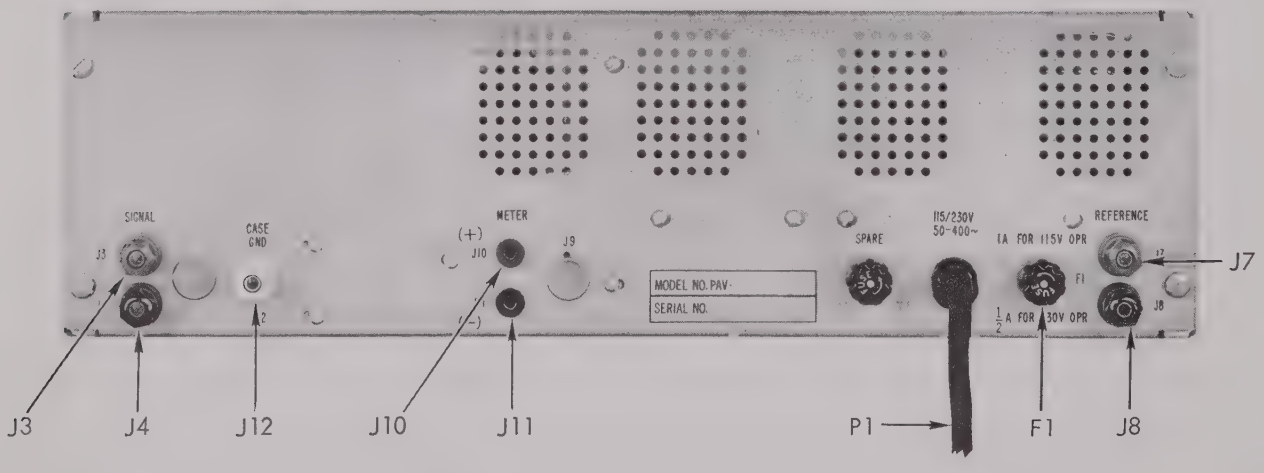


Figure 6-2. Rear Panel View

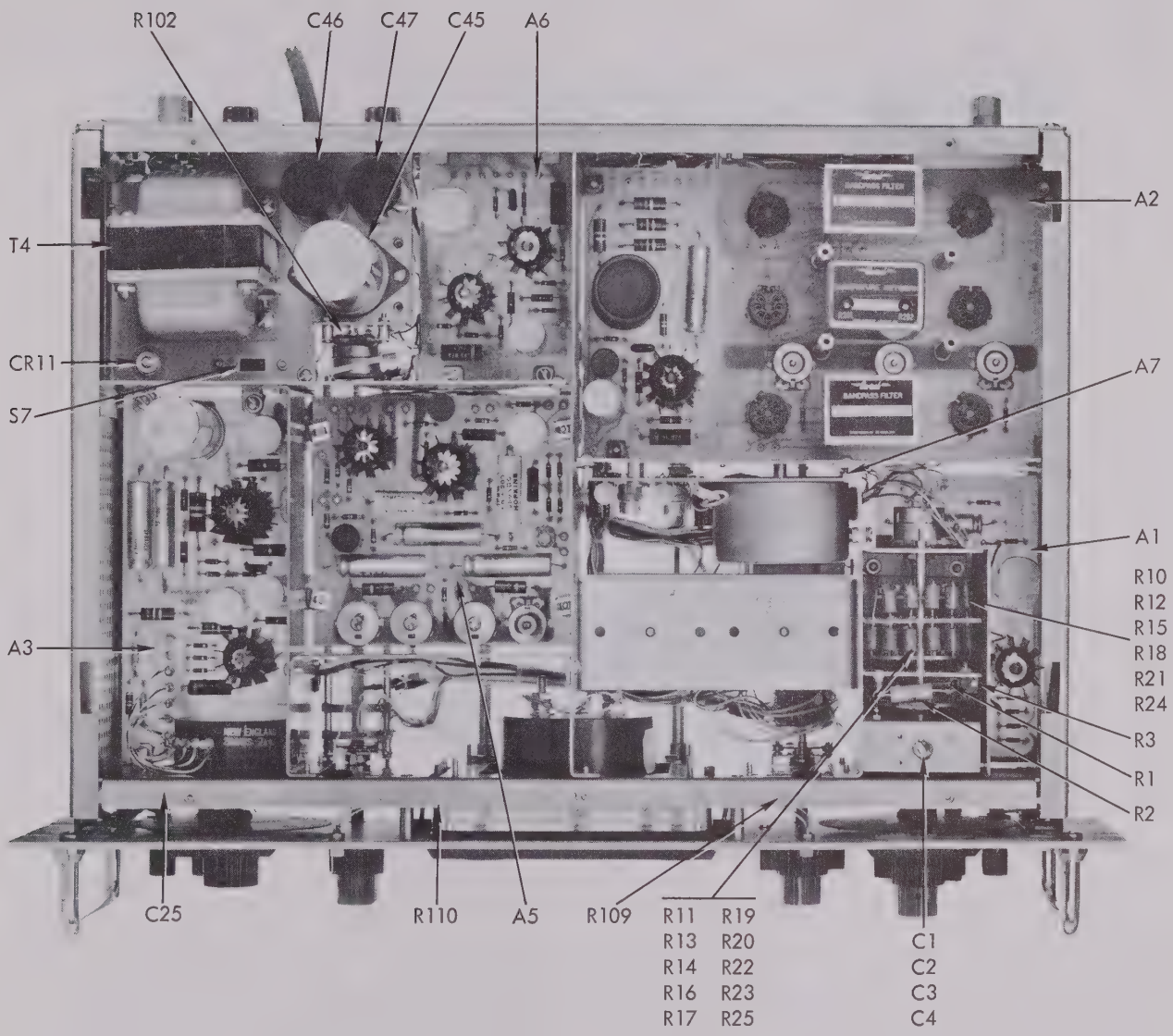


Figure 6-3. Chassis Top View

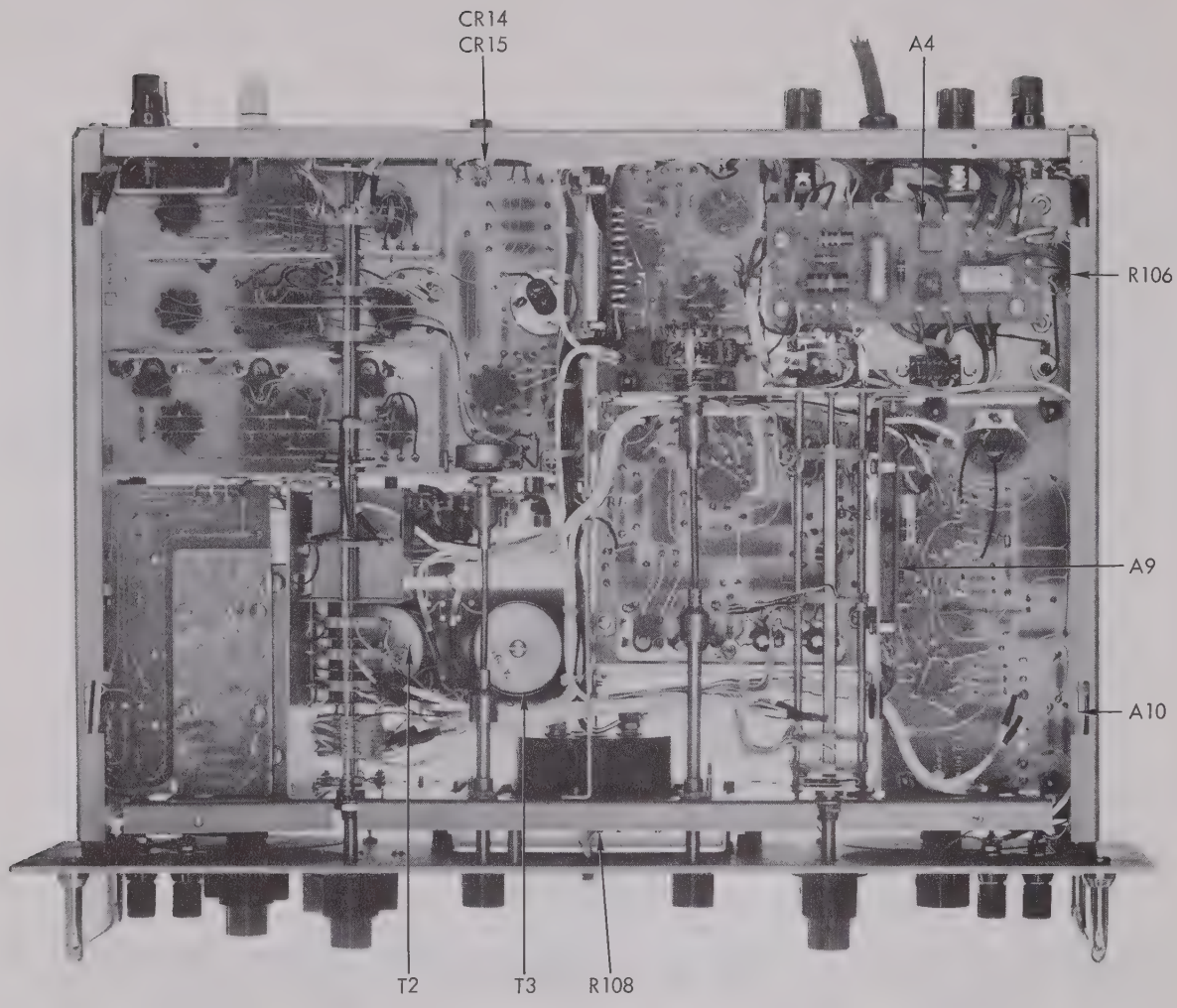


Figure 6-4. Chassis Bottom View

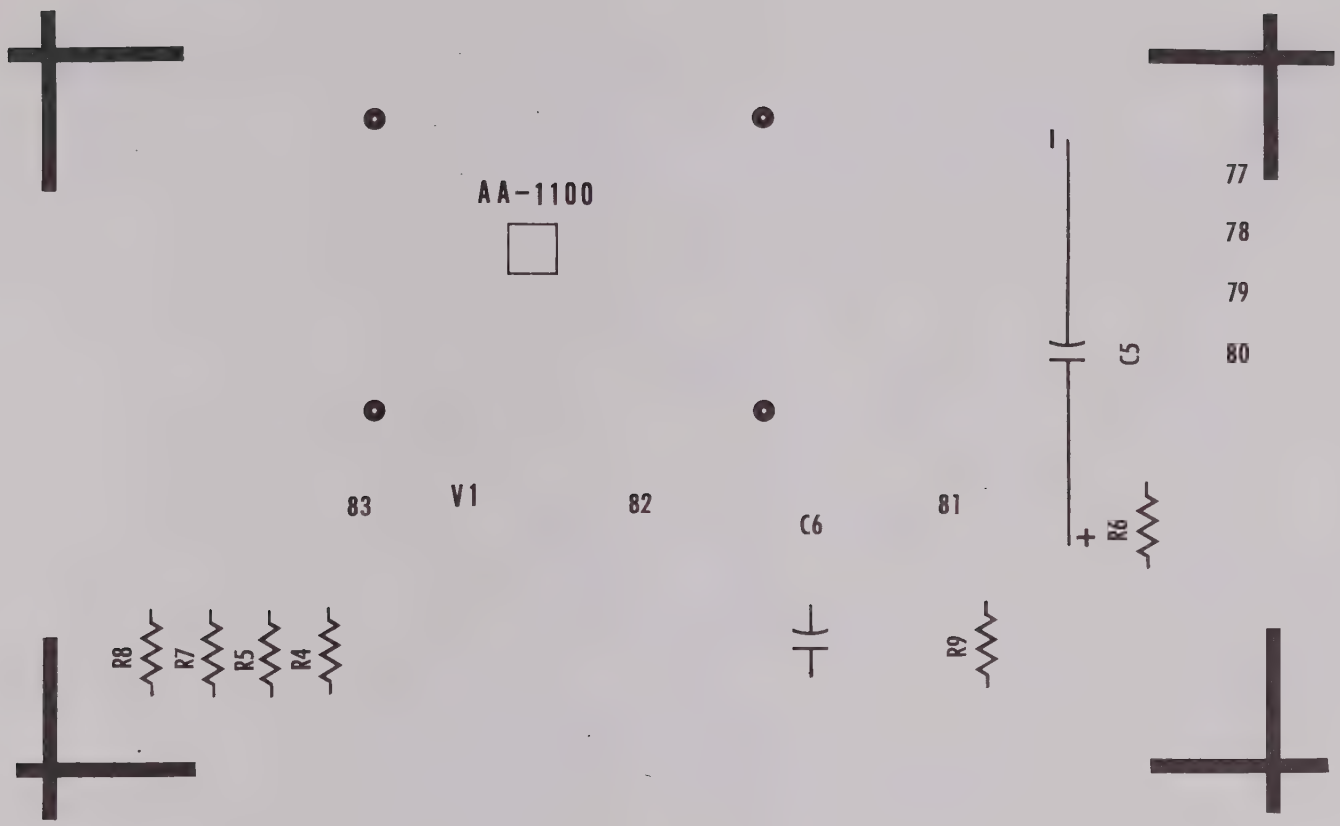


Figure 6-5. Board Assembly, Signal Input

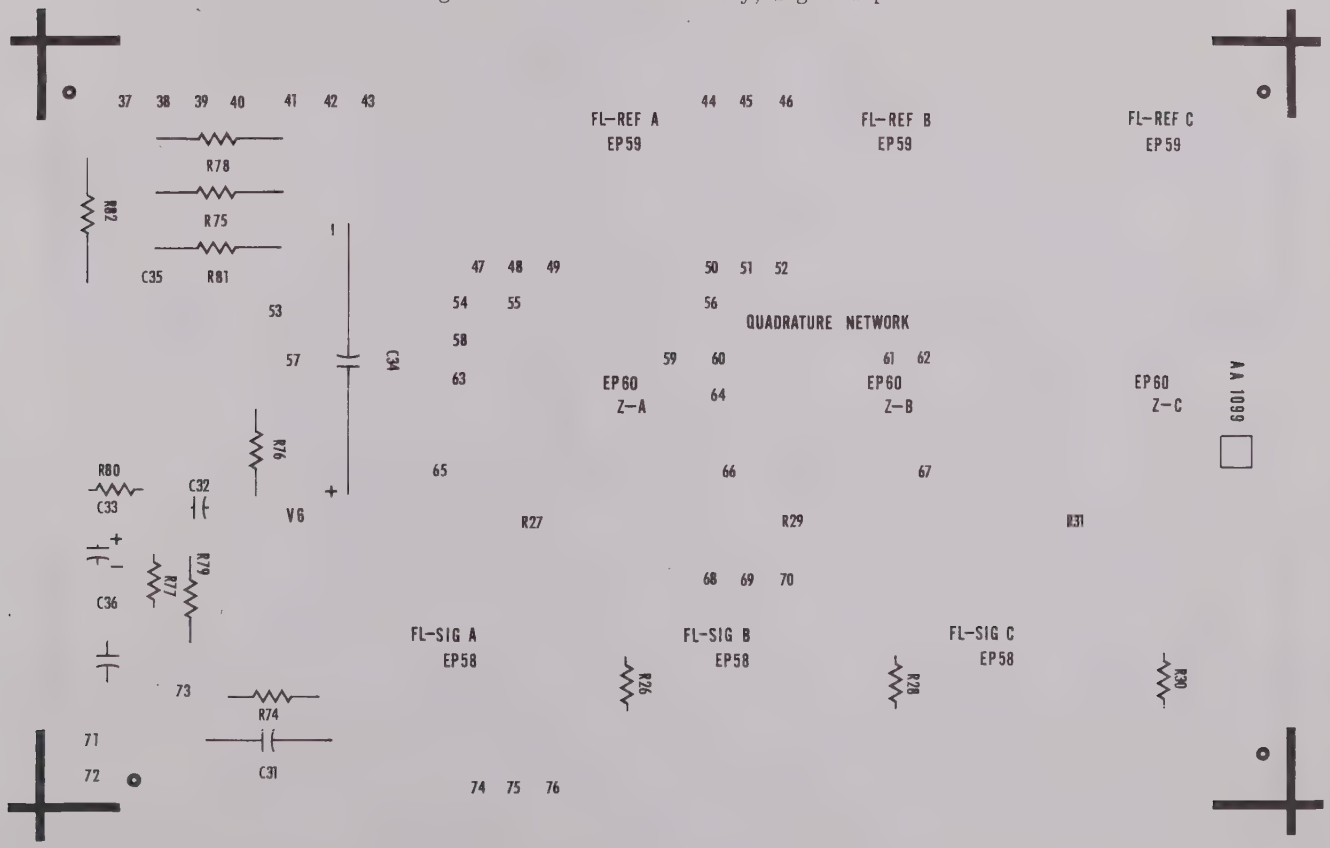


Figure 6-6. Board Assembly, Quadrature Generator

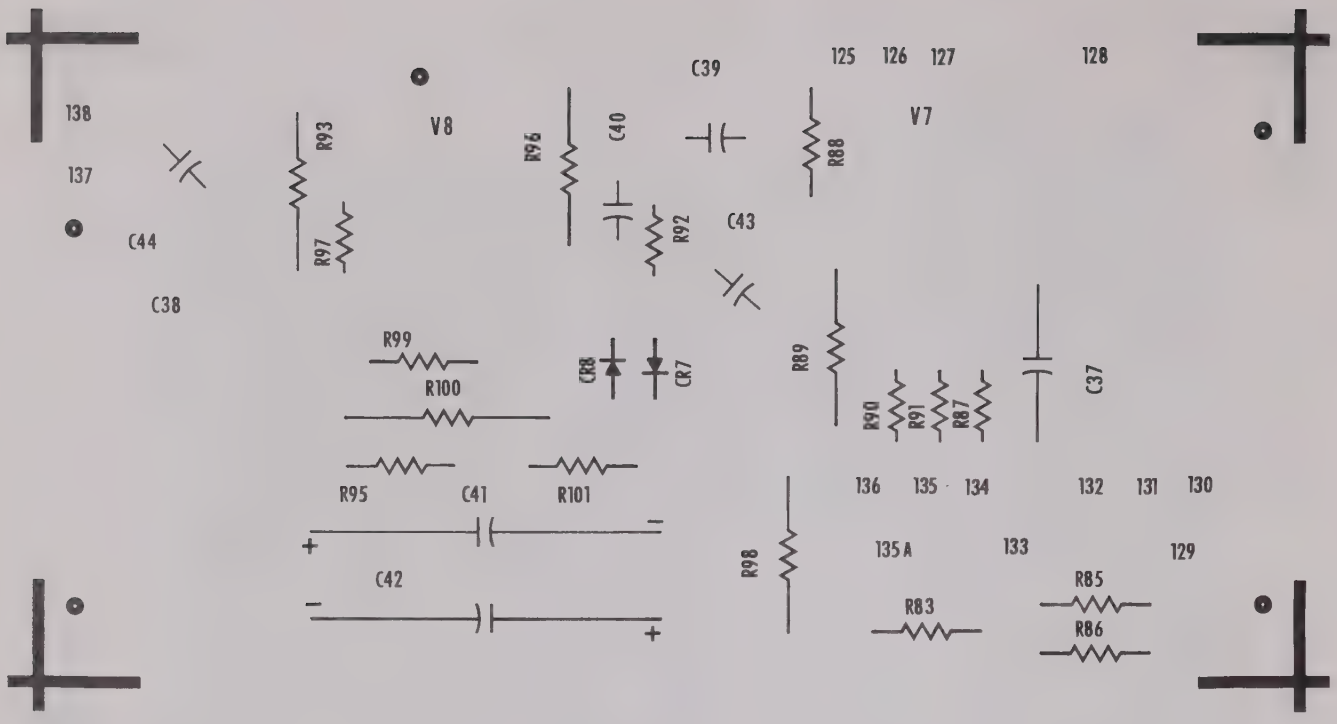


Figure 6-7. Board Assembly, Reference Amplifier

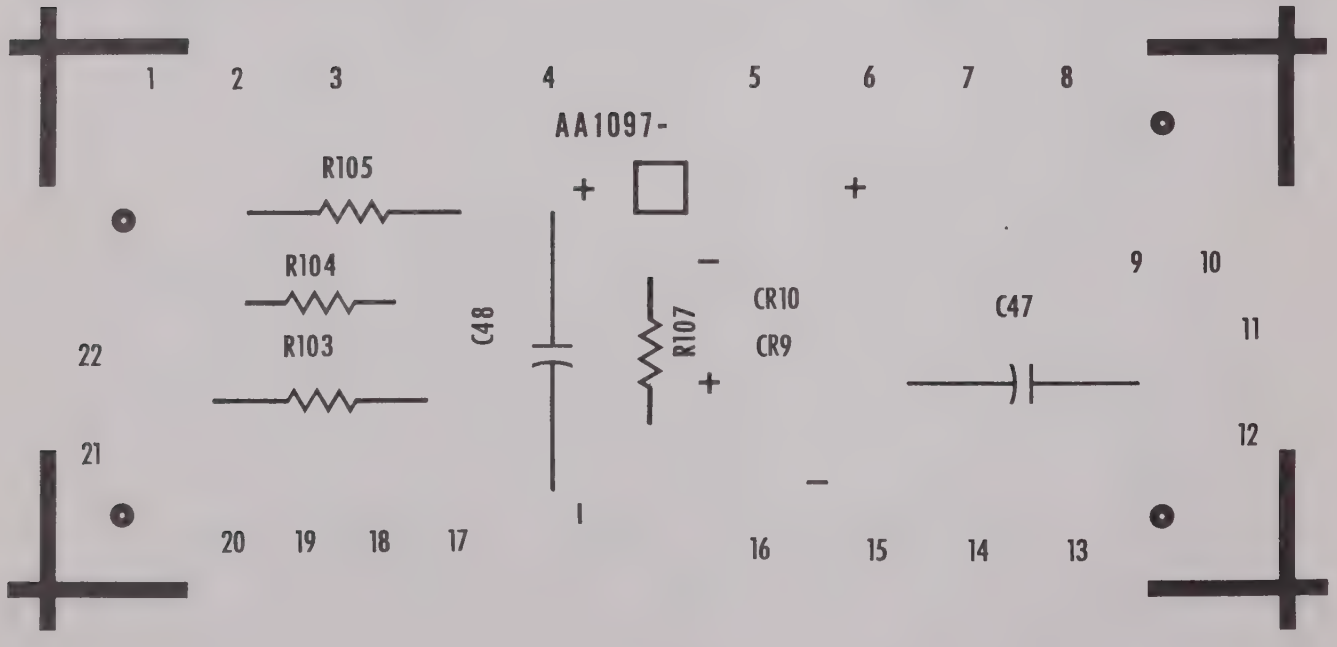


Figure 6-8. Board Assembly, Power Supply

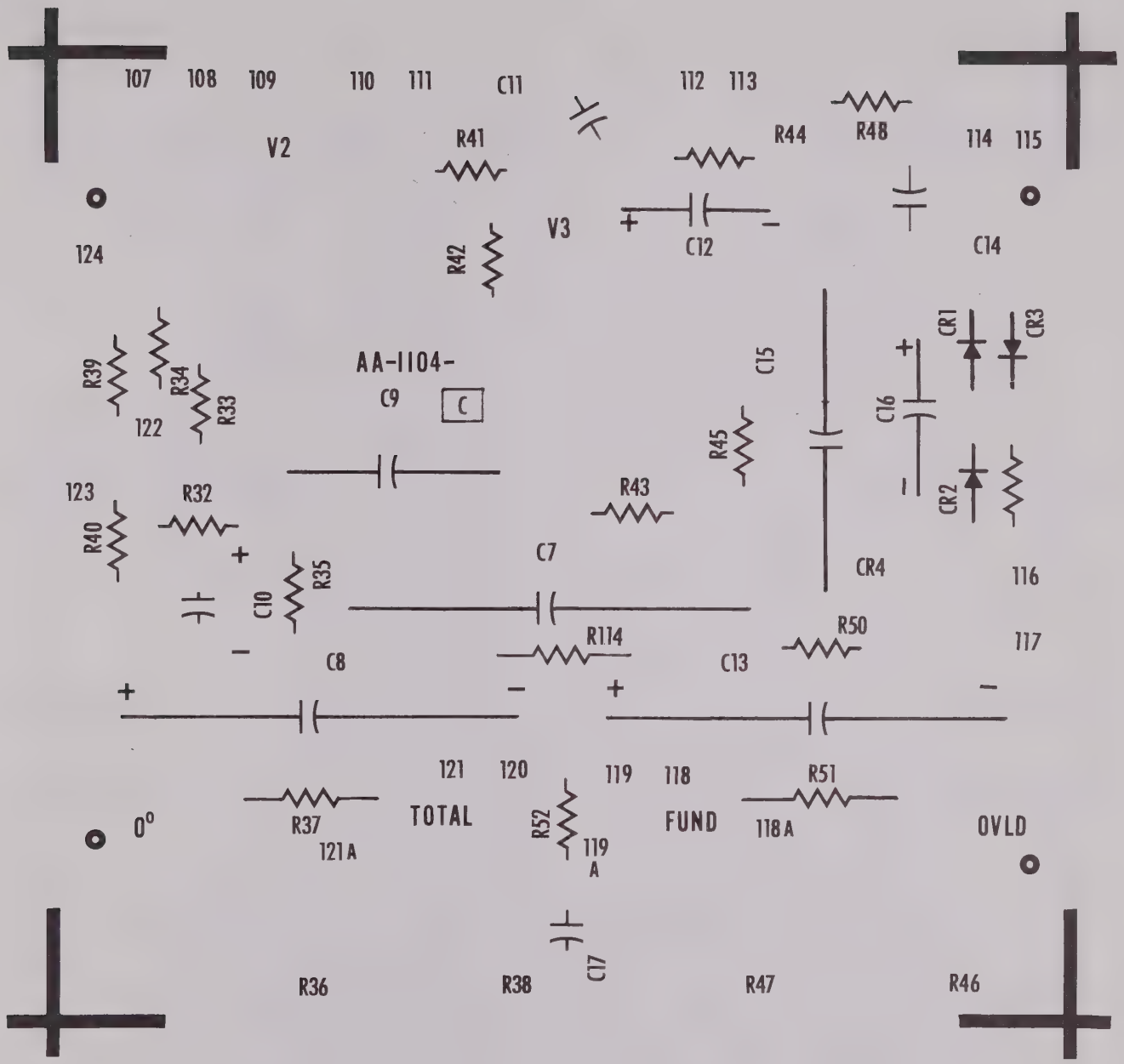


Figure 6-9. Board Assembly, Signal Amplifier

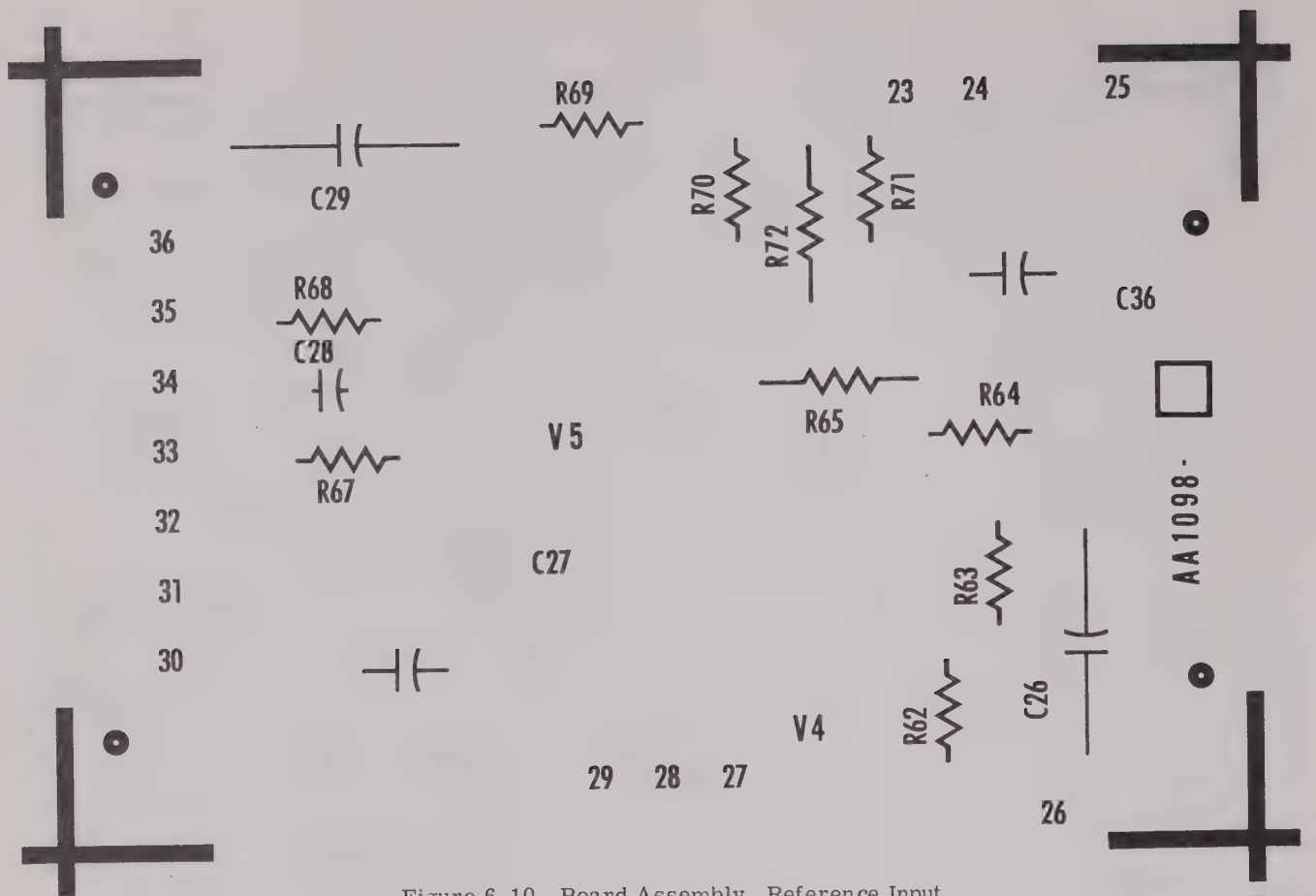


Figure 6-10. Board Assembly, Reference Input

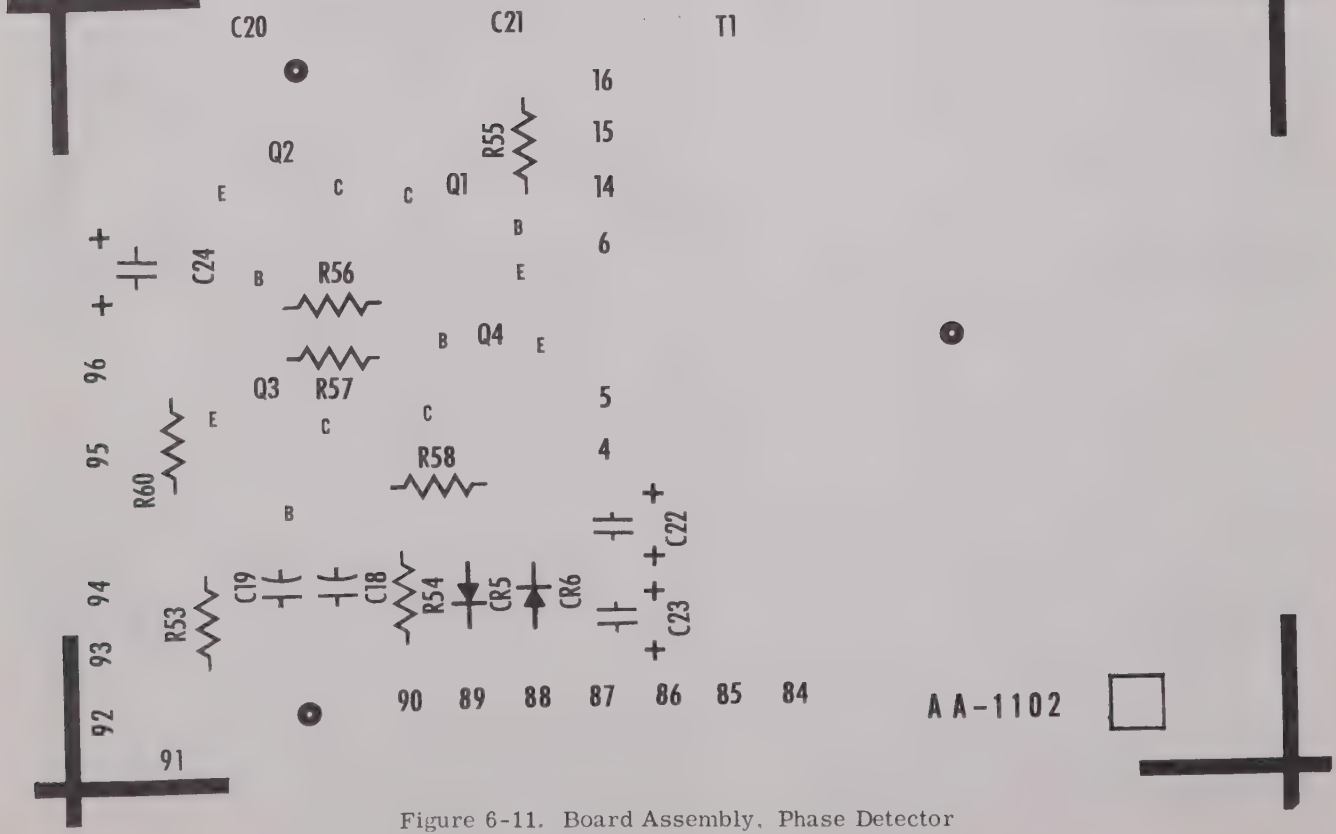


Figure 6-11. Board Assembly, Phase Detector

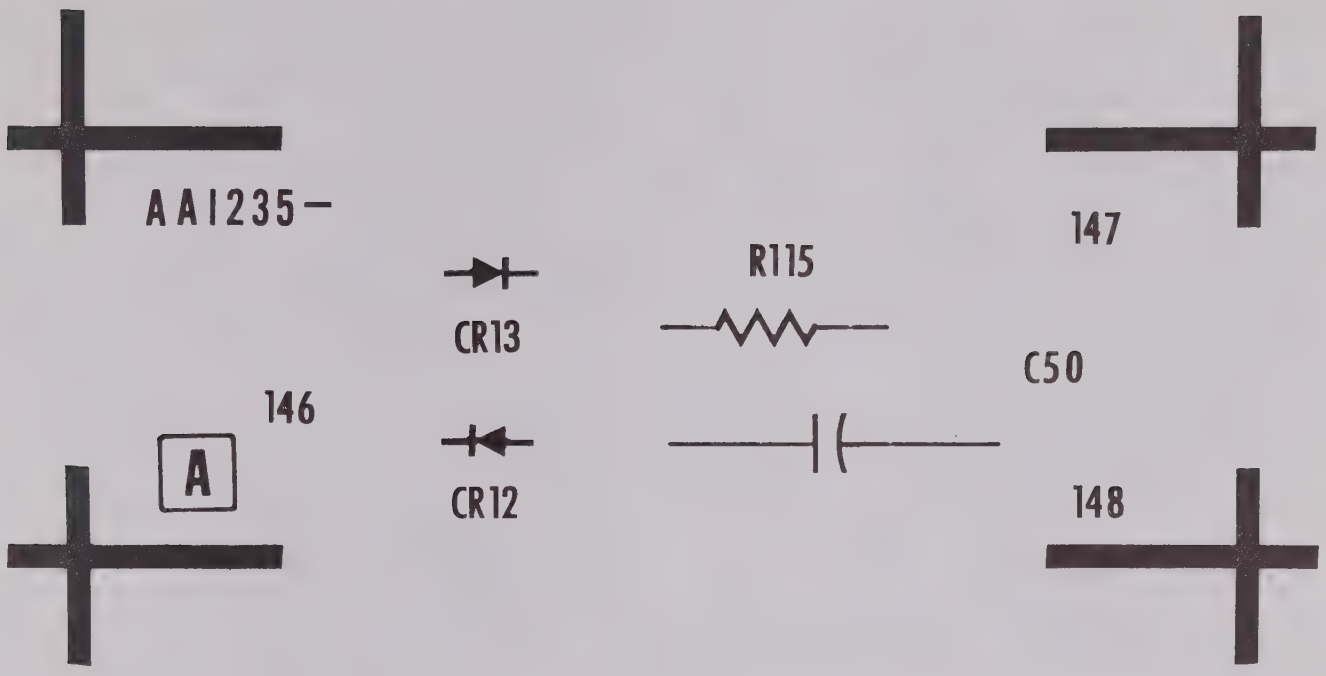


Figure 6-12. Board Assembly, Diodes

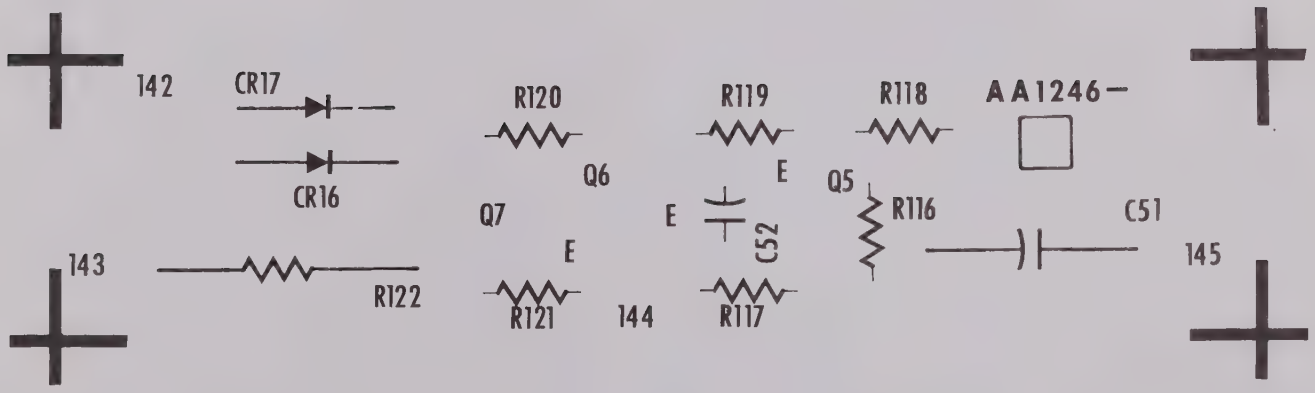


Figure 6-13. Board Assembly, Isolation Amplifier

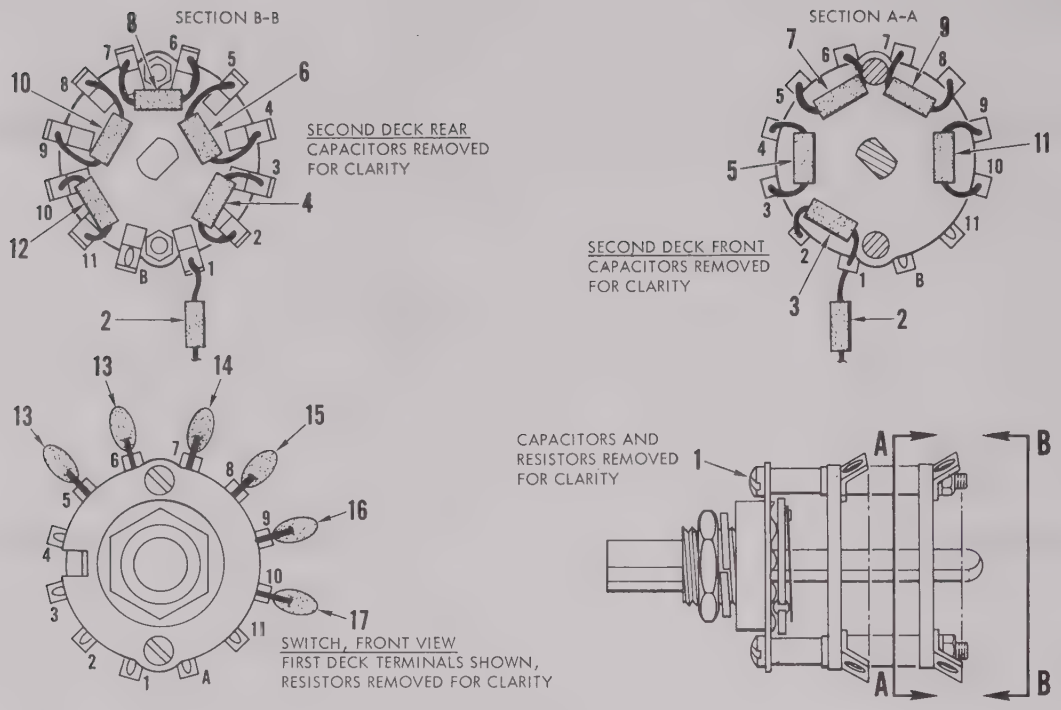


Figure 6-14. Reference Level Assembly

ITEM	DESCRIPTION	MFG	PART NO.
1.	Switch	Singer	SW-300
2.	Resistor, composition, 12K±5%, 1/4 watt		
3.	Resistor, composition, 6.8K±5%, 1/4 watt		
4.	Resistor, composition, 11K±5%, 1/4 watt		
5.	Resistor, composition, 16K±5%, 1/4 watt		
6.	Resistor, composition, 27K±5%, 1/4 watt		
7.	Resistor, composition, 39K±5%, 1/4 watt		
8.	Resistor, composition, 62K±5%, 1/4 watt		
9.	Resistor, composition, 91K±5%, 1/4 watt		
10.	Resistor, composition, 150K±5%, 1/4 watt		
11.	Resistor, composition, 220K±5%, 1/4 watt		
12.	Resistor, composition, 360K±5%, 1/4 watt		
13.	Capacitor, mica, 1 pf±1%	Elmenco	DM15E010F
14.	Capacitor, mica, 2 pf±1%	Elmenco	DM15E020F
15.	Capacitor, mica, 3 pf±1%	Elmenco	DM15E030F
16.	Capacitor, mica, 6 pf±1%	Elmenco	DM15E060F
17.	Capacitor, mica, 15 pf±1%	Elmenco	DM15E150F

SECTION VII

MODEL PAV-2A

7-1. GENERAL DESCRIPTION.

7-2. The Model PAV-2A is the same as Model PAV-1A except for the addition of two isolation transformers, two switches and one binding post. With the addition of these components, the reference and signal input may either be applied directly as in the Model PAV-1A, or through the isolation transformers. Operation and maintenance of the Model PAV-2A is identical to that for the Model PAV-1A, except for the specific differences noted below:

7-3. The standard isolation transformers supplied with the PAV-2A are primarily intended for operation below 3 kc. However these transformers will perform satisfactorily in a bridging circuit up to 10 kc. It is normal for the transformation ratio of the signal isolation transformer to be 10 percent high at 10 kc; however, this is compensated for in the TOTAL mode.

7-4. The maximum voltage rating of the standard isolation transformers supplied with the PAV-2A is equal to 1.0f, where f is in cps.

7-5. OPERATING INSTRUCTIONS.

7-6. Same as for Model PAV-1A except for the addition of the REFERENCE INPUT switch S9, the SIGNAL INPUT switch S8, and PRIMARY SHIELD binding post J13. To apply the reference and signal voltages through the isolation transformers, turn both switches to the ISOLATED position. To apply voltages directly to the instrument input circuitry turn both switches to the NORMAL position.

NOTE

The Model PAV-2A is shipped from the factory with a strap installed between the rear panel SIGNAL binding post (black) and the PRIMARY SHIELD binding post. If no connection between these points is desired, remove the strap.

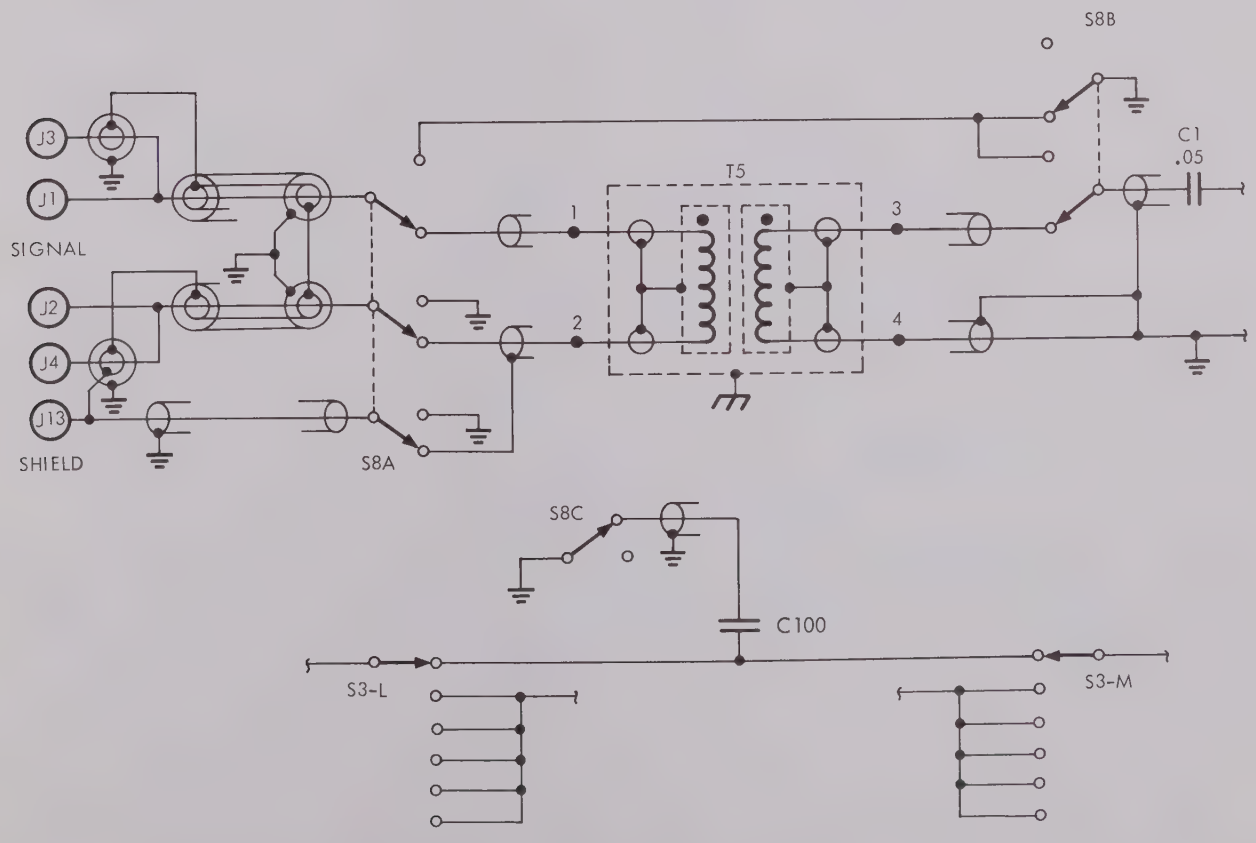


Figure 7-1. Model PAV-2A Signal Input Circuitry

7-7. THEORY OF OPERATION.

7-8. Same as for Model PAV-1A except refer to figures 7-1 and 7-2 for the circuit location of the additional components.

7-9. MAINTENANCE. Same as for Model PAV-1A.

7-10. CALIBRATION. Same as for Model PAV-1A.

7-11. PARTS LIST. Same as for Model PAV-1A except for the addition of the following components:

SYMBOL	DESCRIPTION	MANUFACTURER	PART NO.
J13	Post, binding, green	Superior	DF30GC
S8	Switch, signal isolation, 2 position	Gertsch	SW-275
S9	Switch, reference isolation, 2 position	Gertsch	SW-274
T5	Transformer, signal	Gertsch	TA333
T6	Transformer, reference	Gertsch	TA333
Strap	0.900	Gertsch	AS310
C100	Durmica capacitor, 3600 pf nominal		

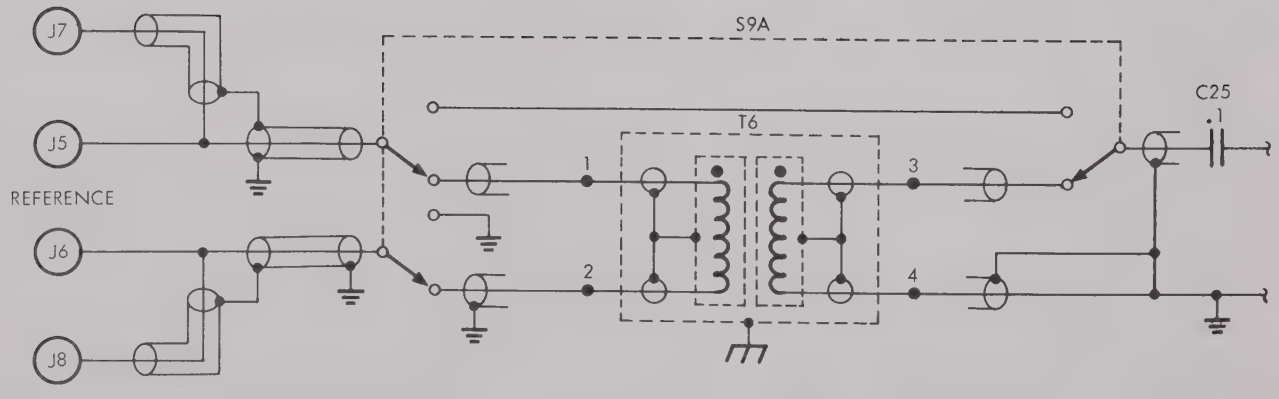


Figure 7-2. Model PAV-2A Reference Input Circuitry

SECTION VIII

MODEL PAV-3A

8-1. GENERAL DESCRIPTION.

8-2. The Model PAV-3A is the same as the Model PAV-1A except for the addition of self-contained isolation transformers. Two sets of transformers are supplied to provide full frequency coverage. With the addition of these components, the reference and signal inputs may be applied directly to the input circuits of the PAV or through isolation transformers (eliminating ground loops). Operation and maintenance of the Model PAV-3A is identical to that for the Model PAV-1A except for the specific differences noted below.

8-3. The isolation transformers used for below 10 kc operation are intended primarily for operation below 3 kc. These transformers will perform satisfactorily in a bridging circuit up to 10 kc. The transformation ratio is approximately 10 percent high at 10 kc.

8-4. The maximum voltage rating of the transformers is equal to 1.0f where f is in cps.

8-5. OPERATION INSTRUCTIONS.

8-6. Same as for Model PAV-1A except as follows:

a. To apply a signal input, greater than 10 kc, through an isolation transformer, turn signal switch S6 (right hand side meter) to the ISOLATED ($f \geqslant 10$ kc) position.

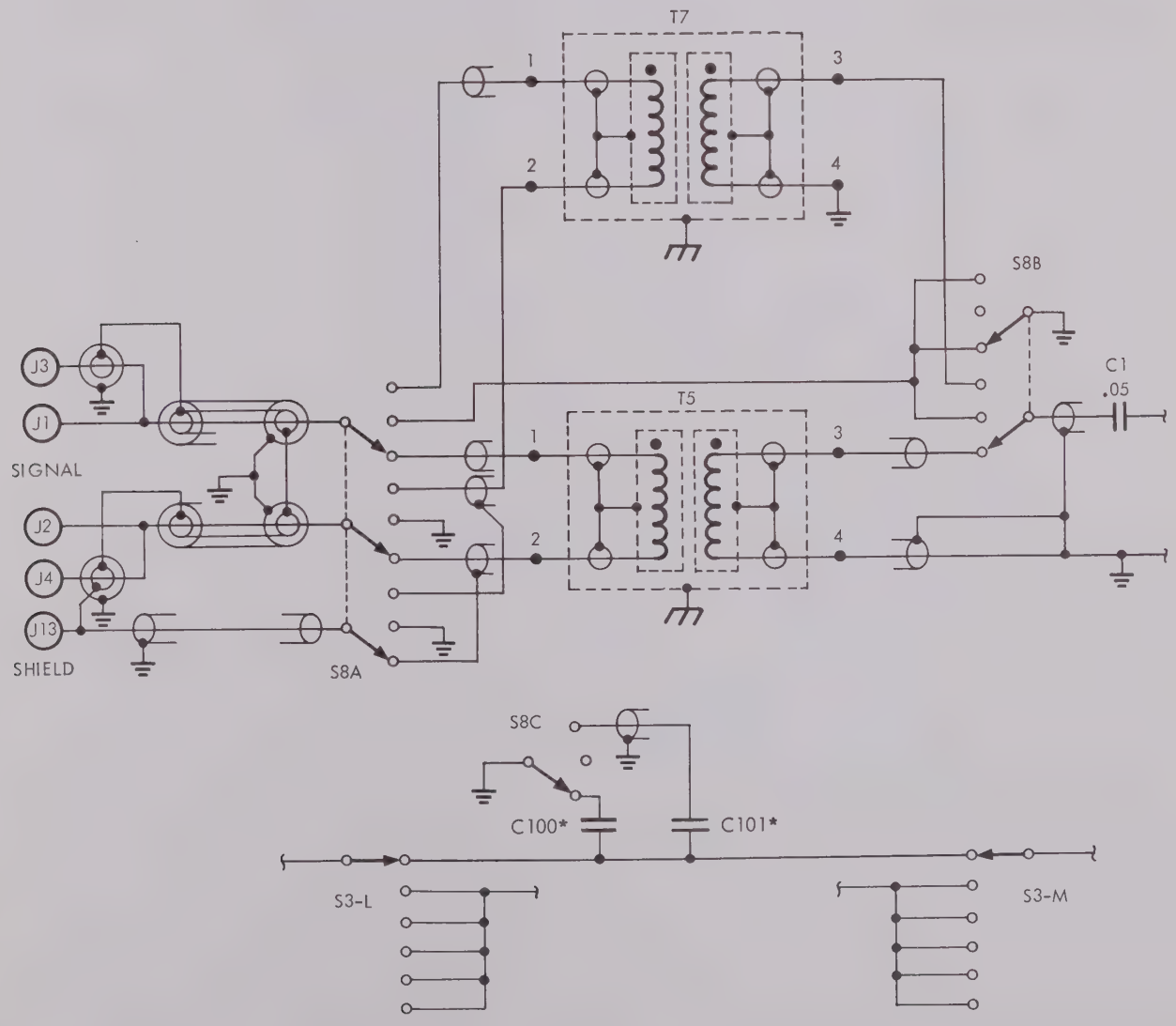


Figure 8-1. Model PAV-3A Signal Input Circuitry

b. To apply a signal input in the 50 cps to 10 kc range, through an isolation transformer, turn signal switch S8 to ISOLATED ($f < 10$ kc) position.

c. To apply a signal input directly to the input circuits, turn signal switch S8 to the NORMAL position.

d. To apply a reference input greater than 10 kc, through an isolation transformer, turn reference switch S9 (left hand side of meter) to the ISOLATED ($f \geqslant 10$ kc) position.

e. To apply a reference input, in the 50 cps to 10 kc range, through an isolation transformer, turn reference switch S9 to the ISOLATED ($f < 10$ kc) position.

f. To apply a reference input directly to the input circuits, turn reference switch S9 to the NORMAL position.

g. To drive the inner shields of the signal input leads and the primary shield of the signal isolation transformer from an external source, remove the strap between binding post J4 (black) and J13 (green) and apply the shield driving source to binding post J13. If no source will be provided, either connect J13 to J4 or case ground (J12).

8-7. THEORY OF OPERATION.

8-8. Same as for Model PAV-1A except as follows:

a. Refer to figure 8-1 for the changes in the signal input circuitry.

b. Refer to figure 8-2 for the changes in the reference input circuitry.

8-9. MAINTENANCE. Same as for Model PAV-1A.

8-10. CALIBRATION. Same as for Model PAV-1A.

8-11. PARTS LIST. Same as for Model PAV-1A except that the following components are added:

SYMBOL	DESCRIPTION	MANUFACTURER	PART NO.
J13	Binding Post, green	Superior	DF30GC
S8	Switch, rotary, 3 position, signal isolation	Gertsch	SW-272
S9	Switch, rotary, 3 position, reference isolation	Gertsch	SW-273
T5	Transformer, signal, 50 cps to 10 kc	Gertsch	TA333
T6	Transformer, reference, 50 cps to 10 kc	Gertsch	TA333
T7	Transformer, signal, greater than 10 kc	Gertsch	TA371
T8	Transformer, reference, greater than 10 kc	Gertsch	TA371
	Strap, binding post	Gertsch	AS310
	Knob, small bar (2 required)	Gertsch	AC-95
C100	Durmica capacitor, 3600 pf nominal		
C101	Durmica capacitor		

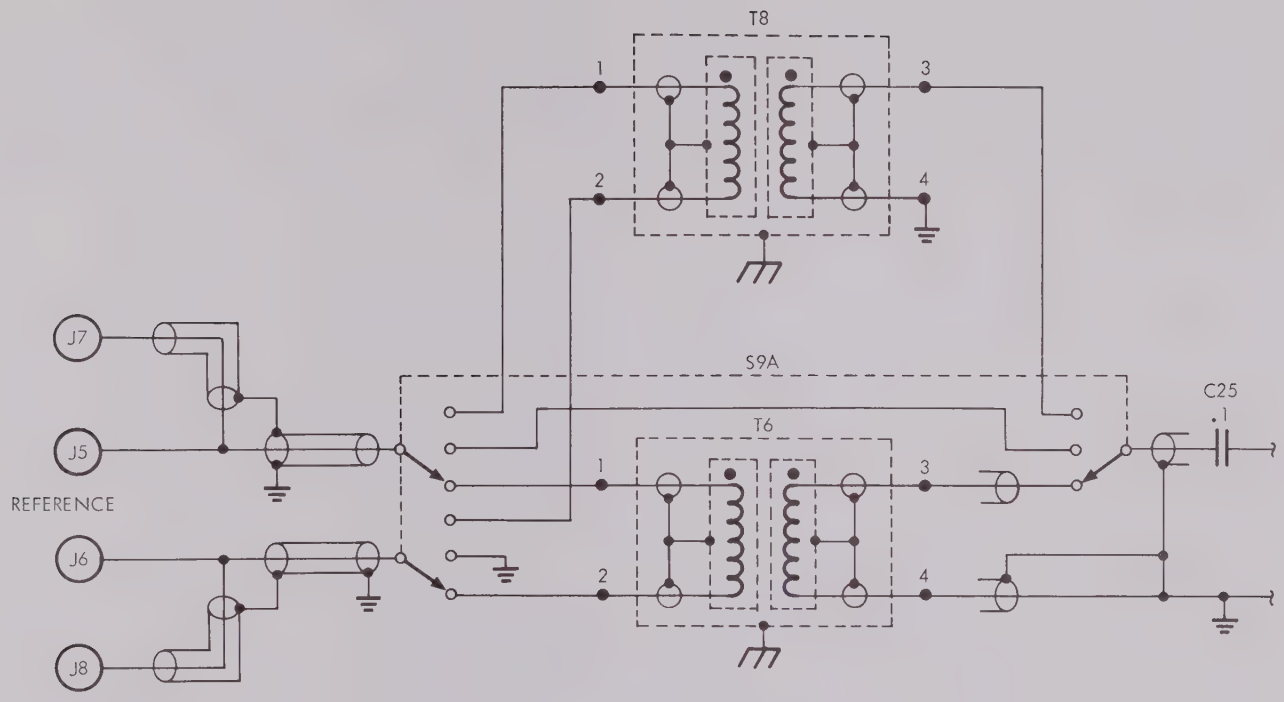


Figure 8-2. Model PAV-3A Reference Input Circuitry

SECTION IX

METER RELAY OPERATION

9-1. GENERAL.

9-2. On Model PAV's with a meter relay, connector J9, relay socket XK1, and meter relay MR-1 are added as shown in figure 9-1. The figure also includes suggested "GO" "NO-GO" circuits.

9-3. DESCRIPTION.

9-4. Meter Relay MR-1 consists of a signal coil(s) and two locking coils (L). The signal coil is connected in series with the meter, to provide a relay closure at full scale meter deflection. One set of locking contacts is closed when the meter deflection is right (or plus) from center zero and the other set is closed when deflection is left (or minus). Current flow through the applicable locking coil then locks the relay in the closed position until the circuit is interrupted externally.

9-5. "GO" "NO-GO" CIRCUITS.

9-6. Refer to figure 9-1 for suggested "GO" "NO-GO" circuits. The external relays are recommended since current flow through the locking coil is limited to a range of 5 to 25 ma (5 ma is required to hold the locking coils). The recommended external relays are Advance Relays series GH relays with 110 vdc, 8000 ohm coils.

9-7. To operate the equipment proceed as follows:

a. Operate the Model PAV in the required function and apply a "NO-GO" signal (either polarity).

b. Down range the VOLTS-RMS switch to the hightest range which provides an off scale indication.

c. Adjust VARIABLE control as required to obtain an exactly full scale indication.

d. Check that the applicable "NO-GO" indicator is lit or that automatic shutdown has occurred.

e. Interrupt the 110 vdc relay supply. In the recommended circuits, press the reset push button.

f. Proceed with tests. Whenever a "NO-GO" condition occurs, interrupt the 110 vdc relay supply to restart the test.

9-8. If the meter relay is removed from the equipment, a jumper must be installed between pins 1 and 2 of the relay socket. Without the jumper, meter M1 is disconnected from the equipment.

9-9. PARTS LIST. The following parts are added to the equipment.

DESCRIPTION	MANUFACTURER	PART NO.
Connector, receptacle, J9	Amphenol	126-221
Socket, relay, 9 pin	Amphenol	77M1P9
Relay	Gertsch	MR-1

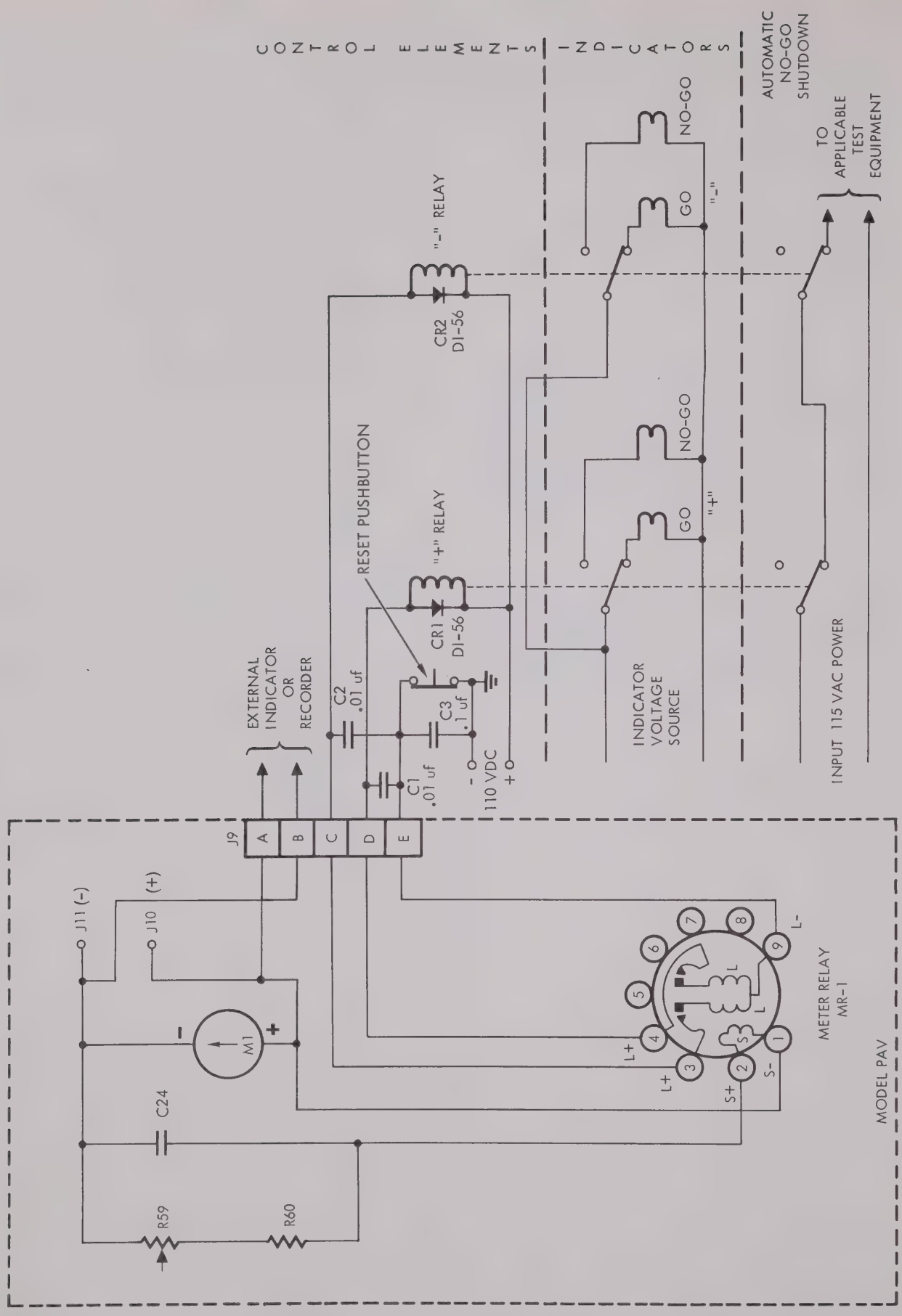


Figure 9-1. Meter Relay Installation

DIFFERENCE DATA SHEET

Models shipped prior to March, 1965

The instructions included in the previous sections of this manual, apply except for the specific differences noted below.

In the earlier models, variable resistor R61 was used as the REF LEVEL control instead of the reference level assembly AA-1143. (See figure DD-1.) With the variable control, the reference input voltage could be set to the REF level marking on the meter.

Otherwise, operation and maintenance instructions are the same.

PART CHANGES

PART	CHANGE
A8	Not Used
A9	Not Used
A10	Not Used
C40	Was 1000 pf nominal value
C50	Not Used
C51	Not Used
C52	Not Used
CR12 thru CR17	Not Used
M1	Was part number MA-14
Q5 thru Q7	Not Used
R61	1 meg potentiometer, CTS part number 37117 (replaced by A8)
R92	Was 10K
R94	Was 1 meg ±10%, composition resistor
R101	Was 2.7K
R113	Was 470 ohm or 1000 ohm ±10%, composition resistor
R114 thru R122	Not Used
R55 thru R58	Was 3.5K
R47	Was 250 ohms

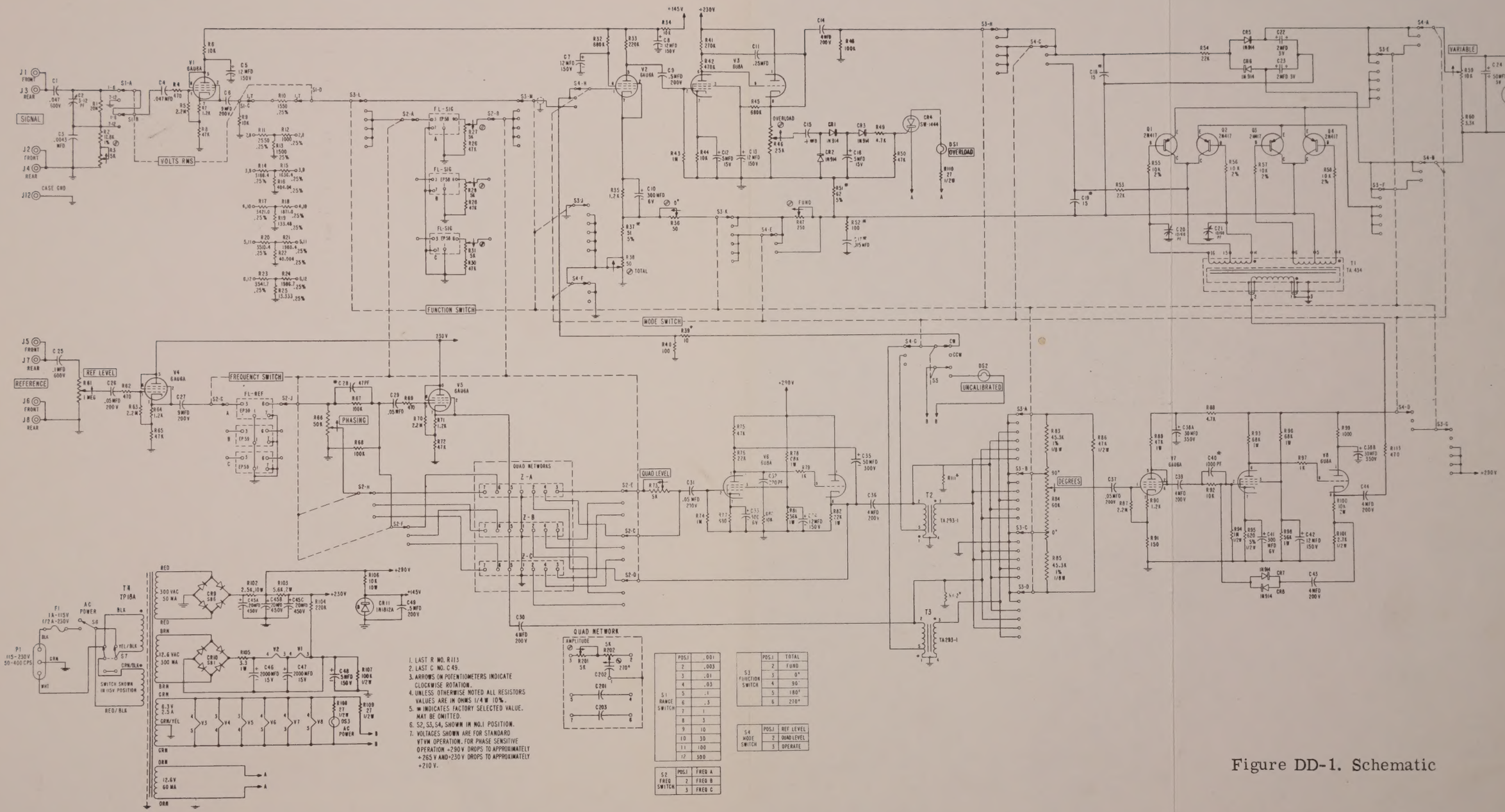
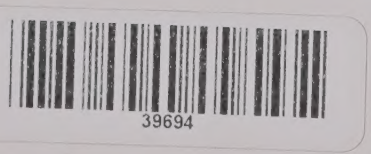


Figure DD-1. Schematic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